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ABSTRACT

A comprehensive history of physiology in America can be obtained from the records of physiology departments. This supplement to "The Physiologist" contains departmental histories of nine institutions. Featured are the physiology departments at: (1) State University of New York at Buffalo: 1846-1986; (2) University of California at Berkeley; (3) University of British Columbia; (4) University of Florida: 1956-1981; (5) University of South Florida; (6) Philadelphia College of Osteopathic Medicine; (7) University of California, Davis; (8) United States Army Research Institute of Environmental Medicine: First Quarter Century; and (9) Medical College of Wisconsin: 1921-1985. Previously published histories and archival materials are also listed and identified by author, institution, period covered, and issue published in "The Physiologist." (ML)

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The Tides of Physiology

Departmental Histories

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Upper left: Student physiology laboratory, 1930, Philadelphia College of Osteopathic Medicine. *Lower left*: Laboratory of Environmental Physiology, State University of New York at Buffalo. *Right*: Toland Hall, ca. 1880, University of California at Berkeley.

The Tides of Physiology
Departmental Histories

edited by Arthur B. Otis
Department of Physiology
University of Florida

A Supplement to *The Physiologist*
Volume 29, Number 5, October 1986
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Bethesda, MD 20814

Preface

Departments are the family units of physiology. They are where physiology happens day by day. Although they enjoy a high degree of individuality and autonomy, they are, at the same time, interdependent on one another. They produce offspring who leave home to found new departments or to enrich old ones. They become revitalized by assimilating the offspring of other departments. Sometimes departments die, and occasionally they are born again.

A departmental history is a family record. Taken collectively such histories form a valuable data bank for a comprehensive history of physiology in America. I urge every physiology department to assemble its family record and keep it up-to-date.

The departmental histories comprising this supplement plus those previously published in *The Physiologist* (see next page) may be considered as contributions to the Centennial Celebration of our Society. Their submission was encouraged in a memorandum sent in 1980 by Orr E. Reynolds to all physiology department heads and in letters written by me in 1980 and 1984. The Centennial Celebration Committee endorsed the project, and at the Committee's request Horace Davenport wrote some suggestions for the preparation of such histories [*The Physiologist* 22(1): 30–31, 1979].

Some 40 manuscripts have been received and with this issue most will have been published in *The Physiologist*. A few authors requested that their efforts not be published but gave permission to have them deposited in the APS archives.

It has been my privilege and pleasure as an Associate Editor of *The Physiologist* to read these histories as submitted. They have varied widely in length, emphasis, and style. I heartily thank everyone who provided a history and gently chide those who promised to but did not.

Arthur B. Otis, *Editor*

Previously Published Histories and Archival Materials

Issue	Author	Institution	Period
18(3): 99–103, 1975	Youmans, W. B.	University of Wisconsin, Madison	1906–1952
20(5): 26–27, 1977	Kaplan, H. M.	Southern Illinois University, Carbondale	1947–1977
21(5): 12–14, 1978	Jaques, L. B.	University of Saskatchewan, Saskatoon	1926–1978
25(1): 39, 1982	Aserinsky, E.	Marshall University School of Medicine, Huntington, WV	1976–1980
25(1): 39, 1982	Santos-Martinez, J.	Universidad Central del Caribe, Cayey, PR	1976–1980
25(1): 40–41, 1982	Brown, E. B., Jr.	Oral Roberts University, Tulsa, OK	1977–1981
25(1): Suppl. 1–96, 1982	Davenport, H.	University of Michigan, Ann Arbor	1850–1923
25(5): 414, 1982	Haddy, F. J.	Uniformed Services University of the Health Sciences, Bethesda, MD	1976–1982
25(5): 414–425, 1982	McGrady, A. V.	Medical College of Ohio, Toledo	1964–1982
25(5): 416–418, 1982	Tansy, M. F.	Temple University, Philadelphia, PA	1863–1982
25(6): 469–474, 1982	Hansel, W., E. P. Leonard, and H. H. Dukes	Cornell University College of Veterinary Medicine, Ithaca, NY	1868–1960
25(6): 474–478, 1982	Dill, D. B.	Medical Laboratories of the Army Chemical Corps, Edgewood, MD	1946–1961
26(2): 64–70, 1983	Chasis, H.	New York University School of Medicine	1841–1960
26(3): 119–120, 1983	Stinson, J. N.	Meharry Medical College, Nashville, TN	1876–1981
26(3): 120–121, 1983	Annegers, J. H.	Northwestern University, Chicago, IL	1894–1982
26(5): 260–266, 1983	Schmidt-Nielson, B. M.	Mount Desert Island Biological Laboratory, Salsbury Cove, ME	1926–1983
26(5): 269, 1983	Elwell, L. H.	Oregon Health Sciences University School of Dentistry	1899–1980
26(6): 366–368, 1983	Kline, D. L.	University of Cincinnati, Cincinnati, OH	1819–1983
27(1): 4–12, 1984	Loew, E. R.	Boston University, Boston, MA	1873–1948
27(3): 113–127, 1984	Rosenfeld, L. M.	Jefferson Medical College, Philadelphia, PA	1842–1982
27(5): 319–324, 1984	Elizondo, R. S., N. Jacobs, and W. W. Moore	Indiana University, Bloomington	1854–1983
27(5): 325–329, 1984	Selkurt, E. E.	Indiana University School of Medicine, Indianapolis	1958–1983
27(6): 385–389, 1984	Horres, A. D.	Medical University of South Carolina, Charleston	1824–1983
28(3): 139–140, 1985	Magee, D. F.	Creighton University School of Medicine, Omaha, NE	1892–1985
28(5): 402–406, 1985	Pitts, G. C.	University of Virginia, Charlottesville	1825–1985
28(6): 482–484, 1985	Boyarsky, L. L.	University of Kentucky, Lexington	1890–1985
28(6): 485–490, 1985	Weiss, A. K.	University of Oklahoma Health Sciences Center, Oklahoma City	1898–1985
28(6): 491–501, 1985	Lessler, M. A., and F. A. Hitchcock	Ohio State University, Columbus	1879–1985
Archives only	Tenney, S. M.	Dartmouth Medical School, Hanover, NH	1797–1983
Archives only	Guyton, A. C.	University of Mississippi, Oxford and Jackson	1903–1984
Archives only	Font, C.	San Juan Bautista School of Medicine, San Juan, PR	1978–1986

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Brief History of Department of Physiology at State University of New York at Buffalo 1846–1986

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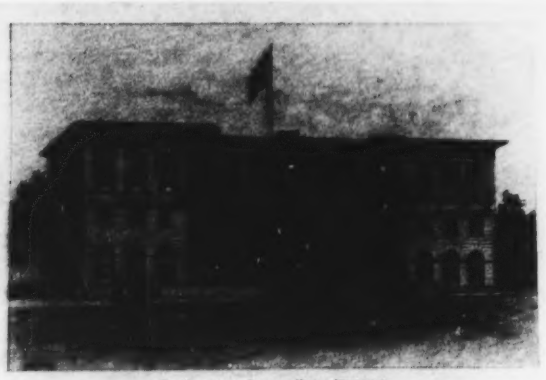


Medical School, 1892–1952.

When the Erie Canal was completed in 1825 it provided not only a new gateway to the west and the Great Lakes but marked the beginning of the growth of Buffalo, then a small village that had been put to the torch 13 years earlier by the retreating British army. Buffalo began to prosper and by 1846 had grown into a thriving city of 30,000 when Millard Fillmore became one of the founding fathers and first Chancellor of a newly created institution, the University of Buffalo. He held this position for 20 years, even while serving in the White House as President of the United States from 1850 to 1853.

At that time the University consisted solely of a School of Medicine, and the first faculty was composed of seven professors between the ages of 33 and 45. This faculty remained intact for five years, a record in the days of pioneering peripatetic professors. The new faculty was made possible through arrangements with the Geneva Medical College, founded in 1826, 100 miles east of Buffalo. Five of the original faculty taught in Geneva in the fall term and repeated at Buffalo during the winter term (2).

Classes were held in the First Baptist Church until 1849 when they were transferred to a new building designed exclusively for the Medical School at a cost of less than $25,000. This building served until 1892 when a new one was completed as a replica of the Palazzo Farnese in Rome. The building was described in the Annual Announcement of the University as "the most tasteful, comfortable, and best arranged college edifice in the United States; perhaps even in the world," and "so well built that it is now pointed out as one of the most attractive buildings of any kind outside of New York City. The magnificent college library contains about 4,000 volumes." The elegant entrance was big enough for a carriage to enter to drop off the professor or a patient. The beautiful lanterns were made by craftsmen in Florence.

For the first 50 years students were admitted upon their preceptor's recommendation; then high school Regents examinations were required, and by 1920, two years of college. The length of study was originally four months for each of two years, devoted to formal courses. Lecture fees in 1846 were $62; matriculation fee, $3; demonstrator's ticket, $5; and graduation fee, $20, bringing the total expense to $90.00 per year, to which must be added board and room, including fuel and light, at $2–3 per week.

Other schools began to slowly crystallize around the School of Medicine, including Pharmacy and Dentistry, and in 1962 the private University of Buffalo was absorbed into the New York State University system.

The instruction of medicine in the United States up to the middle of the last century followed essentially its European antecedents, especially the English model. Vitalism and empiricism dominated the study of physiology, and according to Rothschuh (4), American physiology remained in the preexperimental era until about 1860, followed by the transitional period when new interest in physiology developed, resulting in openings for teaching and experimental work in a few privately endowed laboratories and the realization that the United States had still much to learn from its European antecedents. Among the most eminent pioneers of that period Rothschuh listed John Draper, Silas Weir Mitchell, John Dalton, and Austin Flint, Jr. Both Dalton and Flint started their professional careers at Buffalo as Professors of Physiology.

Charles Brodhead Coventry (1801–1875) was our first Professor of Physiology and Medical Jurisprudence. He clearly belonged to the preexperimental era of American physiology, an established practitioner known for studies and reports on the epidemic of Asian cholera that existed in Albany and New York City. During his first term he actually taught obstetrics and shared his physiology teaching with Austin Flint, Sr., our first Professor of Medicine, who is remembered for the "Flint aortic murmur."

Five years later he was succeeded by John Call Dalton (1825–1899) as Professor of Physiology and Morbid Anatomy, one of the first full-time teachers in physiology in this country whose income did not depend upon private practice. Dalton entered Harvard College at the age of 15, and in his second year was house pupil at the Massachusetts General Hospital when Morton demonstrated the use of ether. Presumably he appears as the second from the left in the famous painting of this demonstration by Hinckley, described as "the sleepy, red-haired boy." In 1847 at the age of 22 he received

Left to right: Charles Brodhead Coventry (1846–1850) and John C. Dalton, Jr. (1851–1855).

his M.D. degree and spent a year with Claude Bernard in Paris. On his return, at the age of 26, he wrote an essay on the corpus luteum in pregnancy and menstruation for which he received a prize of the American Medical Association. It was at this time that he accepted the chair at Buffalo. When he left five years later he had made an indelible mark not only on his successors in our school but also on American physiology because of his introduction into the classroom of anesthetized animals for demonstration of various physiological principles. He was one of the pioneers in the transition of American physiology from vitalism and empiricism to the experimental era in teaching and research. He had learned his lessons well from Claude Bernard, but animal demonstrations "sparked the first antivivisectionist agitation in this country. His valiant defense finally culminated in a book, 'The Experimental Method in Medicine,' 1882, which has sounded the key note for all his successors" (3).

Dalton left in 1855, later becoming President of the College of Physicians and Surgeons in New York City. He was one of the 28 founding members of the American Physiological Society and was elected to the National Academy of Sciences in 1864, a year after it was established by Abraham Lincoln. His book *Human Physiology* went through seven editions. A detailed description of his career has been provided by Reed (3).

The next appointment was a matter of expediency and a great step backward for physiology at Buffalo. This was the appointment of Sanford B. Hunt (1825–1884), whose title was expanded from Professor of General and Descriptive Anatomy to include Physiology. During his tenure he became editor of the *Buffalo Medical Journal* and city editor of the *Commercial Advertiser*. He eventually became anchored to the editorial desk of the daily newspaper to the exclusion of all else.

The next appointment was Austin Flint, Jr. (1836–1915), the son of the former Professor of Medicine. He was a graduate of Jefferson Medical College in Philadelphia in 1857, and his graduation thesis, "The Phenomena of the Capillary Circulation," was published that year in the *American Journal of Medical Sciences*. After graduation he practiced in Buffalo and soon became editor of the *Buffalo Medical Journal*, which his father had founded, and two years later, at the age of 23, was appointed Professor of Physiology and Microscopy. Early in his career he had been strongly influenced by Dalton and continued the Dalton legacy. He left a year later, and in 1861 he accepted the chair as Professor of Physiology and Microscopy at the Bellevue Hospital Medical College and occupied this chair unitil 1897. He also had studied with Claude Bernard and was a true experimentalist, publishing many basic studies, including a five-volume edition of *The Physiology of Man* and a *Textbook of Animal Physiology*. His illustrious career at Bellevue is well documented by Chassis (1).

During the next 50 years (1861–1912) there were three appointments that continued the tradition of teaching and demonstration, and eventually, mandatory physiology laboratories.

William H. Mason (1822–1903) graduated from the Buffalo Medical School in 1859, to become Professor of Physiology two years later, in 1861. Presumably he

Upper left: William H. Mason (1861–1886); *upper right*: Julius Pohlman (1886–1898); *left*: Frederick C. Busch (1900–1912).

Left to right: Sanford B. Hunt (1856–1858) and Austin Flint, Jr. (1859–1860).

also had spent some time with Claude Bernard. He held the post at Buffalo for 25 years. Little is known about him, and quoting from the graduation address in 1874, "he carried forth the practice of experimental teaching of his predecessors (those established by John Dalton), adding something every year to the treasure of knowledge which makes medicine every year more of a science." (Damned with faint praise.)

Julius Pohlman (1848–1898) was born in Hamburg, Germany, and received his medical degree at Buffalo in 1883, to become Lecturer in Physiology three years later after resigning as Director of the Buffalo Museum of Science. He was appointed to give the physiology part of a new spring course that had been established "to satisfy the demand for more specific and special instruction than can be furnished in an already replete winter course." In 1886 when Mason became Emeritus, Pohlman was appointed Professor of Physiology, a position that he held until he died during the 1898–99 school year. As far as can be determined, he published no papers in physiology and was probably more interested in the rich fossil fauna of western New York.

Frederick C. Busch (1873–1914) graduated from Cornell in 1895 and received his M.D. degree from Buffalo in 1897. He was appointed to the professorship of Physiology in 1900 at the age of 27. Before his appointment he had studied embryology at Woods Hole, and the following year worked with Professor Kronecker in Basel, Switzerland, on fibrillation and propagation of impulses in the heart. As Professor he introduced laboratory exercises as a requirement, which up to this time were optional. He published several papers on blood hematocrit, density, and differential counts. His most significant papers were on attempts to transplant the suprarenal gland in animals and one unsuccessful attempt in a patient with Addison's disease.

In 1912 the outlook for physiology changed in Buffalo when Frederick H. Pratt (1873–1958) was appointed Professor of Physiology. Educated at Harvard and a medical classmate of Walter B. Cannon, he had already made an important contribution in a paper describing "The nutrition of the heart through the vessels of Thebesius and the coronary veins," which appeared in the first volume of the *American Journal of Physiology* in 1898. However, his greatest accomplishment came with the epoch-making demonstration of the all-or-none operation of skeletal muscles, and in the words of Fred Griffith, who knew him at Harvard and later came to Buffalo, "thus settling a problem that had perplexed physiologists for half a century and was performed by a technique I have always considered one of the most beautiful physiological experiments ever performed." This was done by the "making of photographic records of the all-or-none response of single skeletal muscle fibers following direct stimuli of graded intensity to single muscle fibers. This was done by constructing a special fine-pointed capillary pore electrode with which single muscle fibers could be stimulated. The magnitude of the contractile response of a single muscle fiber was amplified and photographically recorded by light rays reflected from a droplet of mercury in contact with a single muscle fiber" (5). In 1919 he returned to Boston University, and upon his retirement in 1942 he became president of the Harvard Apparatus Company.

Pratt was succeeded by Frank A. Hartman (1883–1971), the first Ph.D., who came from Toronto where he had been assistant to J. J. R. Macleod of sugar metabolism fame, who received the Nobel Prize a few years later for his discovery of insulin. A copy of his acceptance letter noted briefly the following: salary $3,500, Assistant $1,000; a full-time diener $800, and equipment not to exceed $1,000.

In Dr. Griffith's words, "Hartman soon became preoccupied to the exclusion of all else in an attempt to isolate the vital hormone of the adrenal cortex. No one who hadn't seen it could imagine the magnitude of this enterprize. The Physiology Department became lined with cages containing adrenalectomized cats that had to be regularly injected with extracts, and the floor space was crowded with enormous stills, filters, and what-not used in the extraction and purification of relatively enormous amounts of ox adrenal glands obtained from the stockyard. This extensive setup was financed by relatively enormous grants—for that time—from the Rockefeller Foundation. Hartman practically lived with his cats and this incessant extraction-purification process. As we all know, it finally paid off." Hartman purified cortin, received the Chancellor's Medal (the highest award bestowed by the University of Buffalo, for service to the university and the community), the Gold Medal of the American Medical Association in 1932, and universal applause. In 1934 he accepted a call to Ohio State University.

In 1923 Fred R. Griffith, Jr. (1891–1975), a pupil of Walter Cannon at Harvard, joined Hartman as an assistant professor and took over the chairmanship of the Department in 1934. Griffith's interests were pri-

Left to right: Frederick H. Pratt (1912–1918), Frank A. Hartman (1918–1934), Fred R. Griffith, Jr. (1934–1956), and Hermann Rahn (1956–1972).

marily directed toward the metabolic effects of adrenaline, studies which he had begun while he was still at Harvard. The great variability, however, which he and others were finding prompted him to complete a review of all the possible effects that had been ascribed to adrenaline. The further he delved into that difficult subject, the worse it got. This review terminated 30 years later in the monograph, "Adrenaline, Adrenergic-Sympathomimetic, and Adrenolytic-Sympatholytic Drugs." His research centered about the metabolic and calorigenic effects of adrenaline. Some 50 publications attest to his meticulous studies on the reaction to this hormone.

Dr. Griffith's great impact was as a teacher, and he and Hartman started the Department's graduate program in 1925. During his long reign many medical students spent extra years in his laboratory and later became professors at the Buffalo School of Medicine, while others took academic posts at the University of Rochester, the Peter Bent Brigham Hospital, and other such institutions. In the words of one of his former students (J. W. Boylan), "His lectures were individual works of art. Everything fell into place; nothing was hurried or left incomplete. There was no jumbled crowding in the last minutes of the hour. It was like the completion of a play; the curtain came down—you were left satisfied and fulfilled." When Griffith stepped down in 1956 at the age of 65, he was not ready to retire and continued his teaching of physiology at D'Youville College in Buffalo from 1960 until 1972.

In 1953 the Basic Science Departments of the Medical and Dental Schools left their crowded quarters downtown in the replica of the Palazzo Farnese and relocated in Capen Hall (now Farber Hall) on the Main Street Campus of the university. This major step provided for the first time adequate space for the development of basic science departments and coincided with the new availability of public funds for research. To develop the area of physiology, Dean Stockton Kimball was given funds for a new building, Sherman Hall, and established the Lawrence D. Bell Professorship in Cardiovascular Physiology through the cooperation of the Western New York Heart Association. In 1956 Hermann Rahn, who had spent the last 14 years with Wallace Fenn in Rochester, became Chairman of the Department and planned the space in Sherman Hall, including a special section that he set aside for a future, independent department of biophysics. He also had the opportunity to build a new staff, and by 1961 the young staff consisted of John Boylan (renal physiology), Beverly Bishop (neurophysiology), Suk Ki Hong (renal physiology), Donald Rennie (thermoregulation), Charles Paganelli (cellular transport), Barbara Howell (acid-base regulation), Leon Farhi (pulmonary physiology), Edward Lanphier (hyperbaric physiology), and Werner Noell (neurophysiology). Of this original group all but three (Noell, Boylan, and Lanphier) are still on the physiology faculty.

In 1973 Donald W. Rennie became Chairman of the Department but in 1980 accepted the post of Dean of the Graduate School and Vice President for Research; and Charles Paganelli, Associate Chairman, served for two years as Acting Chairman, until 1982 when Leon Farhi assumed the chairmanship.

During the last 30 years the Department has been responsible for teaching physiology not only to medical students but also to students in dentistry, pharmacy, physical education, physical and occupational therapy, nursing, and graduate students in all the basic science departments. The graduate program initiated by Professor Hartman in 1925 was continued, and over the years 53 Ph.D. degrees and 25 Master's degrees have been granted.

As the research interests of the full-time members developed, certain areas in physiology began to crystallize. Among them a separate section of neurophysiology (now called neurobiology) was established with Werner Noell as Director. The section is presently headed by Donald Faber. This group was joined in 1968 by John C. Eccles who stayed with us for seven years (1968–75) and was an important contributor to the whole area of neurophysiology in the university. In 1975 S. K. Hong,

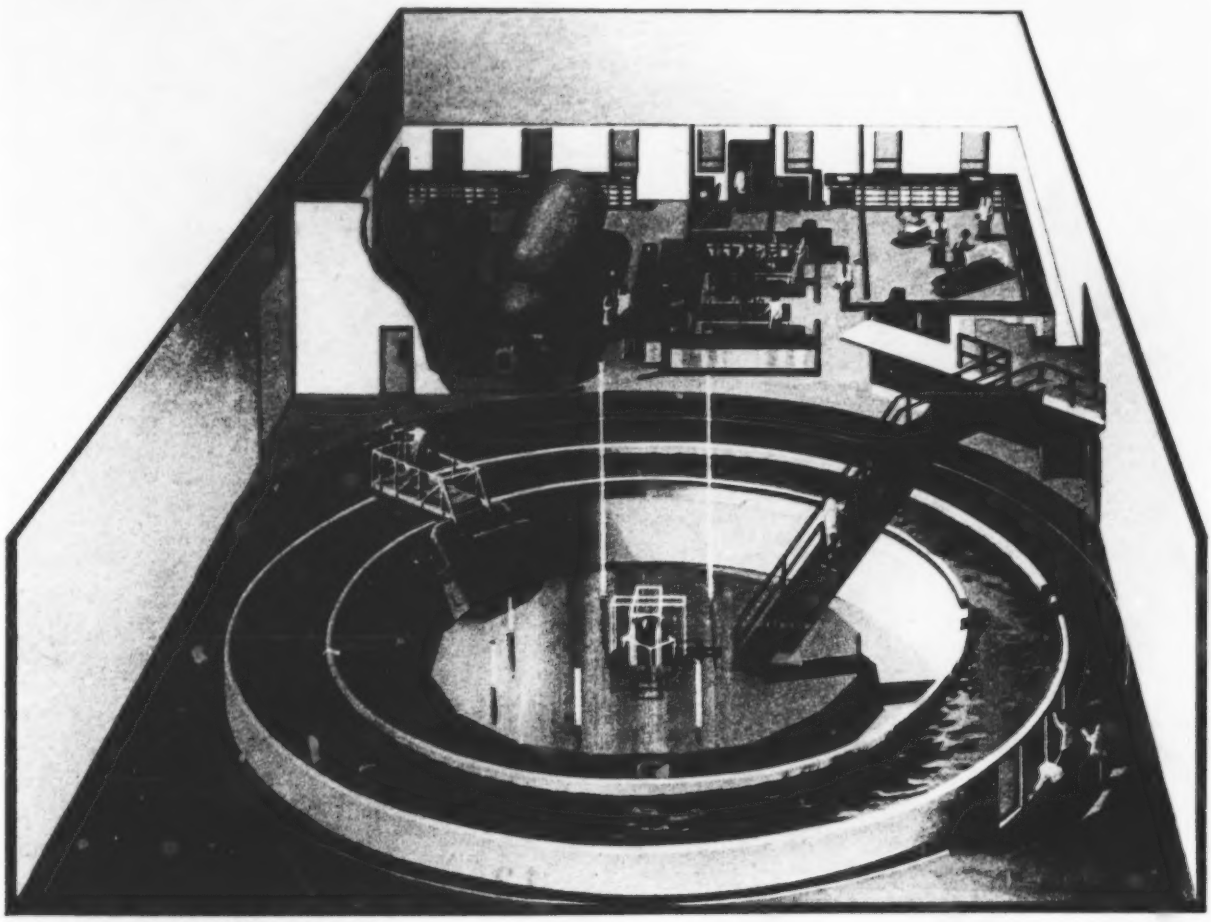
Physiology staff, June 1962. *Top row:* B. G. Covino, C. V. Paganelli, W. K. Noell, L. E. Farhi, and J. W. Boylan. *Bottom row:* D. W. Rennie, E. H. Lanphier, B. Bishop, B. G. Howell, and H. Rahn.

Upper left: Donald W. Rennie (1973–1980); *upper right*: Charles V. Paganelli (1980–1982); *left*: Leon E. Farhi (1982–).

former Chairman of Physiology at the University of Hawaii, rejoined the Department to develop the area of renal physiology. Another group, with interests in the cardiopulmonary area, exercise physiology, and thermoregulation, began to form around the Laboratory of Environmental Physiology, which was built in 1968 under the direction of Leon Farhi. This facility, unique in a university setting, is centered around the human centrifuge. For studies in the physiology of swimming a platform can be attached to the centrifuge cab, which allows one to monitor continuously either a swimming subject or a runner on the banked track. Next to this facility is a hyperbaric chamber, man-rated to 150 atmospheres, originally designed by E. H. Lanphier, presently under the direction of Claes Lundgren.

One of the more unusual activities over the years has been more than 30 field expeditions, launched to various parts of the world to work on problems not easily studied at home. Research has been undertaken on the effects of high altitude, work performance of Eskimos in Alaska, thermoregulation of diving women in Korea and Japan and sponge divers in the Mediterranean, acid-base balance of animals in Alaska and the Amazon, and the gas exchange of bird embryos.

Since 1956 the Department has benefited greatly from 170 Visiting Professors and Postdoctoral Fellows in residence who came to join our research activities.



Laboratory of Environmental Physiology.

The Department of Physiology that 140 years ago consisted of one person now lists 115 full-time members, including 26 full-time faculty, 11 joint professional appointments, 16 visiting professors and postdoctoral fellows, and 18 graduate students, who are supported by an electronics shop (4 employees), machine shop (2 employees), photography (2 employees), 24 technical personnel, and 12 secretaries. With the new space currently under construction the outlook is for continuation of this growth, with excellent facilities and accommodations.

It is a pleasure to acknowledge the great help with much of this historical material that I have received over the years from Robert L. Brown, O. P. Jones, and many others, particularly Augusta Dustan, without whose assistance this history would not have been written.

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Tides of Physiology at Berkeley

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The variegated history of Physiology in the University of California at Berkeley has been shaped by the evolution of the university as a whole, by key administrative decisions, by political considerations, by war, and even by a major earthquake. This continuum of transmutation seems still to be in process in its second century.

Early Days

The conquest of California in 1847 by U.S. military forces during the Mexican War occurred only a few months before the discovery of gold in January 1848 touched off the fabled mass immigration of the Gold Rush. By September 1849 a convention was held in Monterey to draft and adopt a state constitution. It became effective when California was admitted to the Union as the 31st state as part of the Compromise Act in September 1850, without ever having been a territory. The state constitution contained a provision directing the legislature to provide lands and support for a university "for the promotion of literature, the arts and sciences." It was this remarkably short sequence of three years from the military occupation of California to statehood and authorization of a university that led to the adoption of the figure of Minerva as a prominent feature of the state seal.

Whereas the intentions of the founding fathers of the state were noble, the practical realities of funding dictated a much slower course for the legislature in implementing the constitutional mandate for a university. Fortunately, in 1853 the U.S. Congress gave the state 46,000 acres of public land to be sold for support of a "seminary of learning." Then in 1862 the Morrill Act provided an additional 150,000 acres for support of a state college teaching agriculture and the mechanic arts.

Because of some impatience with the legislative process, a number of privately supported colleges began springing up during this period. One of these was opened in Oakland as the Contra Costa Academy in 1853 by several men of the cloth from the American Home Missionary Society in New York, and two years later it was incorporated as the nonsectarian College of California with the Reverend Henry Durant of Yale as its head. A site comprising four square blocks bounded by 12th, 14th, Franklin, and Harrison streets had been purchased, and several small wooden buildings were built to serve as classrooms and living quarters.

The college began its formal career in 1860 with a faculty of eight and a freshman class of eight students with instruction in the liberal arts. In 1862 Wesley Newcomb, M.D., was appointed Lecturer in Natural History and instituted a course in anatomy and physiology given in the first term of the senior year. He was replaced in 1864 by William P. Gibbons, M.D., as Lecturer in Physiology to continue the course.

In addition to the Oakland site the trustees had purchased a 160-acre tract on a hillside in the open country five miles to the north, with the objective of providing a more suitable permanent site for the college. One day in May 1866 they gathered on the tract, with its beautiful vista of the San Francisco Bay directly opposite the Golden Gate, to name it after the eighteenth century British philosopher George Berkeley. This was subsequently taken as the name of the town that grew up around the campus site.

Although the trustees of the College of California had great vision for the future, its finances were rocky indeed. Because of the Civil War, from 1861 to 1865 attendance at colleges generally was down, and the College of California was no exception. However, in 1866 the state legislature voted to establish a College of Agriculture, Mining and Mechanical Arts so as to qualify under the Morrill Land Grant Act. At this point, the College of California made a historic offer to transfer its buildings and land to the state on the condition that "a complete university" be established, in which the liberal arts and sciences were to be taught as well as agriculture, mining, and engineering. In early 1868 the legislature accepted the offer, rescinded its first action, and passed the Organic Act creating the University of California. The act was signed into law by Governor Henry H. Haight on March 23, 1868, celebrated as Charter Day by the university.

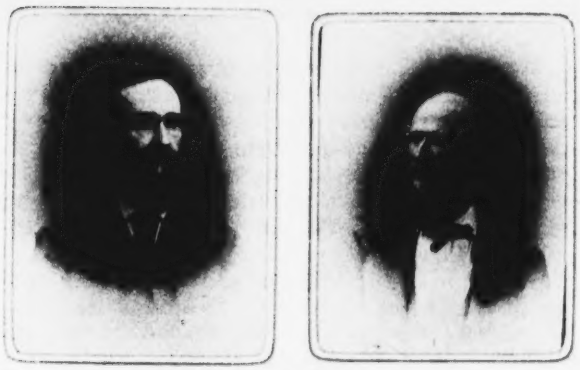
A University is Born

The Organic Act provided for an appointed Board of Regents to manage all the university business affairs. It also provided for a system of separate colleges, each with its appropriate studies, faculty, and students. The initial Board of Regents met and organized in June 1868 for the enormous task before them and set about recruiting a faculty.

On November 17, 1868, the first faculty member to be selected was John LeConte, M.D., as Professor of Physics and Industrial Mechanics. Two weeks later, his younger brother Joseph LeConte, M.D., was elected Professor of Geology, Botany, and Natural History as the fourth ranking member of the faculty.

John LeConte arrived in California via Panama at age 50 in March 1869, two months before the completion of the transcontinental railroad. In conjunction with a small committee of the Regents he outlined the organization of the colleges, set the requirements for admission, arranged the courses of instruction, and issued a prospectus for the coming academic year. His invaluable contribution was recognized on June 1, 1869, by his appointment as Acting President of the University until the first president, Henry Durant, was elected in August 1870.

The LeConte brothers were destined to play a major



Left: John LeConte (1875); *right*: Joseph LeConte (1875).

role in the first quarter century of the university's existence. They were sons of a wealthy Georgia plantation owner, and both received their medical degrees from the College of Physicians and Surgeons in New York in the early 1840s. After a few years of medical practice both entered into academic teaching careers, and by 1856 John had been appointed Professor of Physics in South Carolina College in Columbia, while Joseph held the chair in geology and natural history. In 1862 the college was closed, and John was made a major in the Confederate Army and placed in charge of the government Niter and Mining Bureau to help produce munitions, while Joseph served as a civilian chemist in this enterprise, which continued to the end of the war in 1866. Both resumed their professorships in the reorganized University of South Carolina, but the war had left the state crippled and had swept away their private wealth. Thus they accepted with enthusiasm the invitation in 1868 to join in the development of the incipient University of California, which they did with great distinction until their deaths at the turn of the century. Each of them had more than 100 scientific publications, and each was elected to the National Academy of Sciences.

The University of California opened its doors to 40 male students in September 1869 in the Oakland buildings of the former College of California. John LeConte included a lecture course on physiology and hygiene in the curriculum for all freshman students, but it is not clear who taught the course in that first year because three of the eight original faculty members held medical doctorates. Besides the two LeConte brothers, Ezra S. Carr, M.D., had been appointed Professor of Agriculture, Chemistry, Agricultural and Applied Chemistry, and Horticulture in the summer of 1869. Carr was listed in the 1872–73 Register as being responsible for the course, so it is likely that he inaugurated it.

By the fall of 1873 two classroom buildings had been erected on the Berkeley site, and instruction was moved from the original Oakland site in that year. In 1870 the Regents authorized the admission of women students to the university, with the result that 22 of the 189 students populating the new campus in 1873 were women. However, it was not to be until 1897 that Alice B. Chittenden became the first woman faculty member, among 159 men, when she was appointed Instructor in Drawing.

Simultaneously with the evolution of the private College of California into the state University of California, another private school had developed. In 1864 Hugh H. Toland, M.D., founded the Toland Medical College on Stockton Street in San Francisco, which utilized the City and County Hospital for clinical instruction. When the university came into being in 1868, the Board of Trustees of Toland began discussions of the possibility of affiliation with the university. These culminated in June 1870 in an offer by the Toland Board to the University Regents to transfer their faculty and donate their real estate to become the Medical Department.

The offer was favorably endorsed by the Executive Committee of the Regents, and the 1870–71 Register of the university promptly listed the new Medical Department, together with a University Board of Medical Examiners. It also listed the names of five individuals who were granted the M.D. degree by the university in 1870, presumably as a result of having passed an examination before the Board of Medical Examiners. It is of interest that in this Register, but not subsequently, John LeConte was shown as Professor of Physics, Industrial Mechanics, and Physiology and was listed as a member of the Medical Department faculty in addition to his other duties. He was thus the first, albeit fleetingly, to hold the title Professor of Physiology in the university.

At this point a snag developed when Toland refused to convey the college property unless it was named the Toland Medical Department of the university. The Regents balked at this, and it took until April 1873 before an acceptable compromise was reached by naming the San Francisco building Toland Hall and the

Toland Hall (ca. 1880).

University College of Medicine came into being. In July 1873 another San Francisco private college became affiliated with the university as the College of Pharmacy.

The first operational faculty of the College of Medicine included Melancthon W. Fish, who held the M.D. degree from the Chicago Rush Medical College, as Professor of Physiology. At the outset, a two-year curriculum in medicine was offered, but in 1875 the curriculum was expanded to three years. Physiology was taught during the first two years by lecture and laboratory work involving "vivi-section and the use of the microscope" to classes of about 15 students. Dalton's *Physiology*, Draper's *Human Physiology*, and Flint's *Physiology* were cited as books of reference.

In May 1881, on the recommendation of the faculty of the College of Medicine, the Regents established a College of Dentistry. The new college shared space and faculty in Toland Hall and initiated a two-year curriculum in dentistry in 1882 that was expanded to three years in 1886. Melancthon W. Fish served as Professor of Physiology on both the medical and dental faculties.

The University Matures

While the professional colleges were developing in San Francisco, the character of the academic colleges in Berkeley was also rapidly evolving. In 1872 Willard B. Rising was appointed Professor of Chemistry and Metallurgy to become the first faculty member to hold the Ph.D. degree. Although more individuals holding the Ph.D. joined the faculty, it was not until 1885 that the Regents authorized the granting of the degree by the university itself, and John M. Stillman became the first recipient with a Ph.D. in chemistry.

It is pertinent to note that Stillman had served as Instructor in Chemistry in Berkeley for several years before receiving his Ph.D. and in 1880 had instituted a senior course in physiological chemistry that was concerned with "general relations of organisms to surrounding conditions; chemistry of digestion, secretions, respiration, blood, tissues, and chemical functions of organs." The course was taken over by Edmond C. O'Neill in 1882, who continued it until 1902. During this same period, Joseph LeConte was teaching a sophomore course in structural and physiological botany, together with a junior course in zoology that included lectures on the "comparative anatomy and physiology of animals." Also, John LeConte in 1885 started a sophomore physics course on the "theory of vision" with particular reference to color vision, which he continued until his death in 1891.

John LeConte had been elected President of the University in 1875, and under his leadership it flowered in terms of growth of student body, faculty, curricular offerings, and private donations. However, political clouds had gathered in the state legislature, and in 1879 the storm broke. At issue was the question of whether the university should continue as a single entity or whether it should be broken up into separate Colleges of Agriculture and Mechanical Arts as originally envisioned under the Morrill Act. The issue was settled after lengthy debate by a revision of the state constitution in which the university was once and for all declared "a public trust" subject only to limited legislative control.

Then, in 1881 with their newly affirmed powers, the Regents of the university attempted to exercise unilateral control of faculty appointments without consultation of the Academic Senate. This led to the resignation of John LeConte from the presidency, but not from his chair in physics, before the Regents relented and peace between Regents and faculty was restored.

One more major buttress of the university was added in 1887 when the state legislature for the first time voted an annual levy of one cent on every $100 of taxable property in the state in direct support of the university. A decade later this was increased to two cents and a measure of financial stability was finally assured.

The status of physiology in the University of California in the year of the birth of the American Physiological Society may be briefly highlighted. The university was 19 years old. It comprised five academic colleges in Berkeley and four professional colleges in San Franciso. It had an Academic Senate of 65 faculty, 26 of whom were associated with the professional colleges. There were 12 graduate students and 294 undergraduate students enrolled in Berkeley, together with 69 matriculants in law, 64 in medicine, 36 in dentistry, and 71 in pharmacy in San Francisco for a total student population of 546. Courses in physiological chemistry, comparative physiology, and the theory of vision were being taught in Berkeley, and courses in human physiology were being taught in the Colleges of Medicine and Dentistry in San Francisco.

Although the teaching of physiology was well represented, physiological research in the university was still largely in the offing. The major exception was Joseph LeConte, who, in 1881, published a landmark monograph entitled "Sight: an Exposition of the Principles

Left to right: Melancthon W. Fish (1884); Abraham A. D'Ancona (ca. 1900); Frank W. Bancroft (1900); Jacques Loeb (1907).

of Monocular and Binocular Vision" that served as the major textbook on the subject until after the turn of the century. He also published a number of papers on the subject, as well as a revision of the book in 1897, describing his own research particularly on convergence and accommodation.

Although the collegial structure of the university still prevailed, the 1884 Register for the first time listed groupings of instructional courses by field, cutting across individual college curricula. Thus, in 1884 botany was shown as a discrete instructional entity, and in 1887 zoology appeared as a separate field. This marked the beginnings of the modern department system in the university, even though it was to be a number of years before the administrative concept of an explicit department chairman was formalized.

In 1887 Melancthon W. Fish retired from the chair in physiology in the Colleges of Medicine and Dentistry and was replaced by Abraham Arnold D'Ancona. D'Ancona was born in Brooklyn in 1860 and graduated with an A.B. degree from Berkeley in 1880 after having written a thesis on "The Relations of Ireland to England." He then matriculated in the College of Medicine and received his M.D. in 1884. He served as Assistant in Physiology until he assumed the chair in San Francisco in 1887.

First Flowering of Physiology

As the turn of the century neared, physiology in Berkeley began stirring. In 1891 William E. Ritter joined the faculty as Instructor in Zoology to initiate a course in embryology and in 1892 was promoted to Assistant Professor when he received his Ph.D. from Harvard. Ritter took over the teaching of the principal zoology course from Joseph LeConte in 1896, and in 1897 he pioneered a separate course entitled simply "physiology." Ritter went on to found the La Jolla Scripps Institution of Oceanography in 1909 and served as its first director until his retirement from the university in 1923.

Meanwhile in 1899 Frank W. Bancroft, also a Ph.D. from Harvard, was recruited as an Instructor in Physiology in the Berkeley Department of Zoology. Bancroft was born in San Francisco in 1871 and graduated with a B.S. from the Berkeley College of Agriculture in 1894 before going on to graduate work at Harvard. He took over the physiology course from Ritter with a title change to "general physiology" and pursued research interests in the anatomy, embryology, and physiology of tunicates.

Also in 1899 D'Ancona was named Dean of the College of Medicine in San Francisco and immediately began a campaign to recognize the preclinical fields as areas of pure science and to abandon the custom of appointing practicing physicians to the chairs. In 1895 the curriculum in medicine had been expanded to 4 years, and in 1898 the College of Medicine moved into new buildings on Parnassus Avenue on a 13-acre site donated by Adolph Sutro, also shared by the Colleges of Dentistry and Pharmacy. Thus, D'Ancona's farsighted vision was backed by considerable momentum, and his efforts began to bear fruit with the 1900 appointment as Instructor in Anatomy of Irving Hardesty, a neuroanatomist from the University of Chicago, as the first Ph.D. faculty member in the preclinical area of the College of Medicine. This was followed in 1901 by the appointment of Joseph M. Flint, M.D., as Professor of Anatomy, who had an established reputation as a research investigator at the University of Chicago. Then, in 1902 D'Ancona's campaign was capped by the appointment of Jacques Loeb as Professor of Physiology in the newly created Department of Physiology.

Jacques Loeb was born in the town of Mayen near Doblenz in 1859 and took a medical degree at Strasbourg in 1884. After a year of work with Nathan Zuntz in Berlin on brain physiology he became an assistant to Adolph Fick at Würzburg. Here he became friends with the botanist J. von Sachs and through him saw that he might control animals as Sachs controlled plants. The result was his first two papers on tropisms in animals, one on phototropism and the other on geotropism. However, he was becoming more and more concerned over the military and political conditions in Germany and decided to emigrate to America.

The opportunity came in the form of a brief teaching position at Bryn Mawr College in 1891, followed by his appointment as Assistant Professor in the Department of Biology at the new University of Chicago in 1892. He also started teaching a course in physiology at Woods Hole during the summers. His academic progress at Chicago was rapid, and by 1897 a Department of Physiology had been separated from the Department of Biology, with Loeb at its head. During this period he carried out his classic research on the physiological effects of ions, which culminated in his discovery of artificial parthenogenesis and antagonistic salt action in 1899.

Thus in 1902, when he was invited to join the University of California, Loeb had established impeccable credentials as a leading scientist and was a member of APS. Furthermore, on a visit to the California coast during the winter of 1898–99, he had been impressed by the general climate and the opportunity to work on marine material the year around. Loeb accepted the offer of the chair in Physiology with several provisos: that he be provided with research facilities in Berkeley, that he be provided a small seacoast laboratory, that he be allowed to bring several of his aides with him from Chicago, and that while he assumed overall responsibility, instruction of the medical students in San Francisco was actually to be carried out by some of his aides.

A local benefactor was quickly found to provide a gift of $35,000 to build the Rudolf Spreckels Physiological Laboratory, which was completed by 1903 conveniently near the Chemistry Building and the Faculty Club. The building provided lecture and laboratory facilities for the instruction of about 50 undergraduates, faculty office space and research laboratories, and a departmental library. Special provisions were also made for the investigation of marine animals. This structure served the needs of Physiology on the Berkeley campus until the present Life Sciences Building was constructed in 1930.

A second benefactor, Morris Herzstein, financed the erection of a private laboratory near the Stanford Hopkins Marine Station in Pacific Grove for the use of the Department of Physiology. The laboratory was in use by 1905 and served the Department until 1916.

Top: Rudolf Spreckels Physiological Laboratory (1920). *Bottom*: Sea Urchin Aquarium, Rudolph Spreckels Physiological Laboratory (1905).

In the fall of 1902, Martin H. Fischer, M.D., one of Loeb's assistants, arrived from Chicago to teach the physiology offerings in San Francisco as Instructor in Physiology. He was accompanied by John B. MacCallum, M.D., and Georges Bullot, M.D., who served as Assistants in Physiology. Loeb himself did not arrive until December 1902.

A reorganization of the curricular structure of the Berkeley colleges also occurred in 1902, which established the concept of the major by field rather than by college. Physiology was designated as one such field so that students could earn the undergraduate B.S. degree in physiology or the graduate M.S. degree in physiology, both in the College of Natural Sciences.

By 1903 physiology was listed as a separate department in Berkeley and included Loeb as Professor, Fischer as Assistant Professor, and MacCallum and Bullot as Assistants in Physiology. Frank W. Bancroft, together with his physiology courses, had been transferred from Zoology and was also listed as Instructor in Physiology. The Department roster was completed by Charles G. Rogers, M.A., who had accompanied Loeb from Chicago with an appointment as Assistant in Physiology.

On Loeb's arrival in Berkeley there followed a period of intense activity in physiology. He founded the serial *University of California Publications in Physiology* in 1903, which promptly became the medium for many of his papers as well as for those of others. He attracted a number of distinguished visitors to Berkeley, among them Wilhelm Ostwald, Svanté Arrhenius, and Hugo de Vries. He was elected to the National Academy of Sciences. He oversaw the thesis research of Charles G. Rogers on "The effect of various salts upon the survival of the invertebrate heart," who in 1905 became the recipient of the first Ph.D. degree in physiology granted by the university and went on to serve as Professor of Comparative Physiology at Oberlin for many years.

Loeb attracted numerous other graduate students who went on to notable academic careers. Among them were Charles D. Snyder, the second to receive the Ph.D. in physiology at Berkeley in 1906 and who served as Professor of Physiology at Johns Hopkins University until 1941, and Arthur R. Moore, who became Professor of Physiology at Rutgers and subsequently at Oregon. Loeb also formed a life-long friendship with W. J. V. Osterhout, who was on the Botany faculty in Berkeley at the time, which led to their collaborative founding of the *Journal of General Physiology* in 1918.

The San Francisco earthquake of April 1906 caused extensive damage to the College of Medicine buildings and resulted in a decision to move the first two years of the medical curriculum to Berkeley. Wooden buildings for the Anatomy Department and the Pathology and Hygiene Department were quickly erected near the Rudolf Spreckels Physiological Laboratory, and medical instruction continued without serious interruption. It may be noted here that, although the preclinical departments were physically located in Berkeley, administratively they continued as divisions of the College of Medicine and were supported budgetarily from that source. This arrangement went on until 1958.

In the fall of 1905 T. Brailsford Robertson, born in Scotland, matriculated as a graduate student in physiology after having received his B.S. at the University of Adelaide, and in 1907 he was the third to receive a Ph.D. in physiology at Berkeley. In that year Rosalind Wulzen, who was born in Oakland in 1882, began graduate work in physiology after having received the B.S. degree from Berkeley. She received the M.S. degree

University Botanical Garden (1904). *Front row* (*left to right*): E. J. Wickson, Jacques Loeb, Eugene W. Hilgard, Hugo de Vries, and Svanté Arrhenius. *Back row*: W. J. V. Osterhout (second from *left*), and John B. MacCallum (fourth from *left*).

Left: Rosalind Wulzen (ca. 1940); *right*: Samuel S. Maxwell (ca. 1915).

in physiology in 1910; in 1914 she became the first woman to receive the Ph.D. in physiology at Berkeley, having written a thesis entitled "The anterior lobe of the pituitary body in its relationship to the early growth period of birds."

Changes began to occur in the Department faculty at this time. Fischer resigned to take a professorship of pathology in the Oakland College of Medicine and Surgery and was replaced by John B. MacCallum as Assistant Professor of Physiology in January 1905 to teach the medical physiology course. Later that year Theodore C. Burnett, M.D., joined Loeb and MacCallum in physiological research as Assistant in Physiology without salary. Burnett, a native of Brooklyn, received his medical degree from Columbia University in 1887 and practiced in New England until 1899, when health problems prompted him to move to California. Having independent means he alternated winters in Santa Barbara with summers on his ranch near Mount Shasta until his health was restored. He became intrigued with Loeb's work through a chance meeting with MacCallum and joined the laboratory.

In early April 1906 MacCallum died of tuberculosis at age 30, just two weeks before the San Francisco earthquake, and was replaced by Samuel S. Maxwell that fall. Maxwell was born in Ireland in 1860 and received his Ph.D. in physiology under Loeb at the University of Chicago in 1896. In 1902 he was appointed Instructor of Physiology at Harvard; from there he came to Berkeley as Instructor in Physiology to spend the remainder of his academic career.

When T. B. Robertson received his Ph.D. under Loeb in 1907 he too was added to the faculty as Assistant Professor of Physiology. This was followed by the appointment of T. C. Burnett as Instructor in Physiology in 1909 to regularize his connection with the department.

A major turning point for Physiology at Berkeley occurred in 1910 when Loeb accepted an invitation to join the Rockefeller Institute of Medical Research in New York. This brought to a close an exciting ferment of eight years of major scientific activity engendered by Loeb's tenure at Berkeley. In this period he published nearly 100 papers on subjects ranging over artificial fertilization, tropisms, colloid chemistry, physiological effects of electrolytes, and the segmental character of the respiratory center of the mammalian medulla. He also published two of his classic monographs, *The Dynamics of Living Matter* in 1906 and *Artificial Parthenogenesis and Fertilization* in 1909.

Loeb was an ardent and outspoken mechanist who had a profound influence on philosophical thinking at the beginning of the twentieth century. His views are exemplified by a quotation from his *The Organism as a Whole* published in 1916: "If we substitute for the indefinite term environment the individual physical and chemical forces which constitute environment, it is possible to show that the influence of each of these forces upon the organism finds its expression in simple physicochemical laws and that there is no need to introduce any other considerations." Although Loeb's concept was perhaps overly simplistic, it is fair to say that he sowed the seeds of experimental physiology in Berkeley which were to flourish in later years.

An Ebb of the Tide

However, more immediately, a series of profound changes in the character of the Department was initiated by Loeb's departure. Maxwell was placed in charge, and the next year Bancroft resigned to join Loeb at the Rockefeller Institute. He was replaced by Arthur R. Moore, who had just completed his Ph.D. degree in physiology at Berkeley. At the same time, T. B. Robertson had mounted a campaign to change the departmental name to Department of Physiology and Physiological Chemistry, which was done in 1912.

Moore resigned in 1914 to take an appointment at Bryn Mawr, and he was replaced by Rosalind Wulzen, who had just completed her Ph.D. work. Thus Wulzen became not only the first woman to receive the Ph.D. degree in physiology from Berkeley but was also the first woman faculty member in Physiology.

The differences between Maxwell and Robertson, now both Associate Professors, continued and in 1915 the departmental name was again changed, this time to Department of Physiology and Biochemistry. Finally, in 1916 Robertson triumphed by receiving promotion to Professor and being placed in charge of a new Department of Biochemistry and Pharmacology, while Maxwell was left as Associate Professor in charge of the old, renamed Department of Physiology. At the same time a graduate student, Lillian M. Moore, was appointed Instructor in Physiology, although she did not receive her Ph.D. until 1918.

From 1916 to 1920 the makeup of the Department of Physiology remained static and comprised four faculty members: Maxwell as Associate Professor, Burnett as Assistant Professor, and Wulzen and Moore as Instructors. During this period Maxwell developed a research interest in the equilibrium functions of the labyrinth of the shark, which eventually culminated in an important monograph *Labyrinth and Equilibrium* published in 1923. Burnett concerned himself with the effects of temperature on striated muscle contraction, Wulzen continued her work with the anterior pituitary, and Moore investigated the regulation of body temperature.

In 1920, in an obvious attempt to upgrade the department, the university administration brought in Robert Gesell from Washington University of St. Louis as Professor of Physiology. However, this arrangement was short-lived, as Gesell departed for the University

of Michigan in 1922, where he went on to his distinguished career of many years.

Leadership of the department was thereupon restored to Maxwell, but with two changes: he at long last received promotion to Professor, and he received the additional formal title of Chairman, which was introduced at that time. Nevertheless, little else changed. Burnett received promotion to Associate Professor and Moore was promoted to Assistant Professor in 1924, but it was not for three more years when Maxwell retired that the next major evolution occurred.

It is of interest that in the years of Loeb's personal influence 13 Ph.D. degrees in physiology were granted at Berkeley, whereas during the even longer period of Maxwell's reign only five were granted. Also, it is evident that, with the notable exception of the attempt to bring in Gesell, the Physiology faculty was entirely ingrown. Although it could boast a direct lineage from Loeb, a measure of stagnation had occurred.

The Tide Turns

On Maxwell's retirement in 1927 James M. D. Olmsted was appointed Professor of Physiology and Chairman. Olmsted was born in Iowa in 1886 and on graduation from Middlebury College in Vermont spent three years as a Rhodes Scholar in Queen's College at Oxford. After a few years of high school and liberal arts college teaching he matriculated as a graduate student at Harvard, where he received the Ph.D. in zoology in 1920. He then joined the faculty in Physiology at Toronto; from there he came to Berkeley.

Olmsted had been strongly influenced by Sherrington at Oxford, and later by Loeb at Woods Hole, and by 1927 had attained a substantial reputation as a neurophysiologist with particular interest in the visuomotor mechanisms of the eye. On Olmsted's arrival in Berkeley, Rosalind Wulzen departed to take a position at Oregon State College, where she went on to a notable career in the field of nutrition.

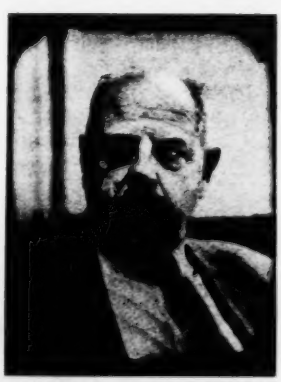
Olmsted immediately proceeded with his rebuilding plans for the Department by recruiting Sherburne F. Cook as Assistant Professor of Physiology and Milton I. Rose as Instructor in Physiology, both in 1928. Cook, born in Massachusetts, had received his Ph.D. in biology from Harvard in 1925 and had spent two years in Otto Warburg's Berlin Laboratory and at Cambridge with Barcroft before coming to Berkeley, while Rose had just finished his Ph.D. in physiology at Yale. However, Rose left Berkeley in 1930 to enter medical school.

Cook remained at Berkeley during his entire distinguished career. His early research interests were in respiratory pigments and biological oxidations; they turned to investigation of the phosphorus metabolism of bone when P32 first became available from the Berkeley cyclotron. During World War II Cook became actively involved in studies on high-altitude decompression sickness being conducted on the campus in the Donner Laboratory under John H. Lawrence. After the war Cook returned to his work on bone, which led ultimately to procedures for estimating the rate of bone fossilization and a major advance in the analysis and demographic interpretation of the contents of prehistoric California Indian middens for which he is well recognized.

In June 1929 T. C. Burnett followed Maxwell into retirement, and in August of that year Lillian Moore died unexpectedly at age 42 of an acute agranulocytosis. Olmsted had recruited Eric Ogden as Instructor in Physiology to replace Burnett that fall; in 1930 Harold F. Blum was appointed Assistant Professor of Physiology to replace Moore and Israel L. Chaikoff was appointed Instructor in Physiology to replace Rose. Thus, within the short span of three years, a complete turnover of the Department of Physiology had occurred, which coincided with the move from the old Rudolf Spreckels Physiological Laboratory to the new Life Sciences Building.

Ogden, a native of London, had taken his medical degree at University College in 1925 and worked with Starling. He served as Assistant in Physiology at University College until coming to Berkeley in 1929, bringing with him the art of the heart-lung preparation and modern cardiovascular physiology.

Blum, born in California, received both his A.B. and Ph.D. degrees in physiology at Berkeley, the latter in 1927. His thesis work on "The recovery of contractility after contraction of cardiac muscle" was done under the guidance of Maxwell and represented a direct lineage from the influence of Jacques Loeb. After a year as Assistant Professor at the University of Oregon he spent two years as Instructor in Physiology at Harvard Medical School before returning to Berkeley in 1930. His teaching responsibilities involved participation in the medical physiology course and sharing the course in general physiology with Cook. His research interests



Left: James M. D. Olmsted (1941); *right*: Sherburne F. Cook (1964).

Life Sciences Building (1930).

began developing in photobiology, which led to his subsequent brilliant career in that field.

Israel L. Chaikoff (1947).

Chaikoff, also a native of London, matriculated in the University of Toronto in 1920 and received his B.A. in 1924, his M.A. in 1925, his Ph.D. in physiology under John J. R. Macleod in 1927, and his M.D. in 1930. When he began his long and illustrious career at Berkeley in 1930, he brought with him a solid interest and training in carbohydrate and fat metabolism, a field in which he went on to make many fundamental and important contributions, including pioneering use of radioisotopes in the study of intermediary metabolism. Chaikoff died in January 1966 at age 63 of complications from lifelong chronic allergic disease. It is noteworthy that in his 36 years of teaching he guided nearly 100 graduate students to the Ph.D. and worked with almost that number of postdoctoral fellows, many of whom have attained eminence as independent investigators. He was unquestionably the most prolific mentor in the history of the Department as well as being one of its truly outstanding scientists.

The last of Olmsted's initial series of appointments was of Nathan W. Shock as Assistant Professor of Physiology in 1932. Shock was born in Indiana and recieved the Ph.D. in psychology at Chicago in 1930. He remained there two more years for postdoctoral work with A. B. Hastings before coming to Berkeley. His research was with the newly formed Institute of Child Welfare, which had begun a series of longitudinal studies to delineate physiological and mental development in humans from birth. As the subjects matured the name was changed to the Institute of Human Development. Shock played a major role in setting the course of this heroic effort, which is still in progress, and eventually went on to direct the National Institutes of Health Gerontology Research Center in Baltimore, Maryland.

Despite the Great Depression of the 1930s, the department saw a period of both active teaching and research. Not only were the core courses of general and mammalian physiology being taught by a vigorous, young staff but special courses were added on the physiology of the reflex arc, comparative physiology, physiology of the circulation, physiology of the endocrines, physiology of the eye, physiological effects of light, and physiology of growth and development in the child. In addition to the 65 first-year medical students, the courses served the departmental academic students and the campus at large, which by now numbered 17,000 students; e.g., the elementary physiology course had an attendance of several hundred students. The tempo of graduate instruction in physiology also began to quicken, so that while in the decade 1925–35 only 8 Ph.D. degrees were conferred, during 1935–45 there were 21 degrees earned.

Blum resigned from the university in 1938 to become a research fellow of the National Cancer Institute, shortly before publishing his classic monograph *Photodynamic Action and Diseases Caused by Light.* Shock departed in 1941 to go to Baltimore and was replaced for a year by Evelyn Anderson Haymaker as Assistant Professor of Physiology.

World War II and Postwar Surge

In 1942 Leslie L. Bennett joined the department as Instructor in Physiology. Bennett, a native of Denver, received his A.B. from Berkeley in 1933 and went on to Ph.D. work in endocrinology under Herbert M. Evans, receiving the degree in 1937. At that time Evans was Professor of Anatomy and Director of the famed Institute of Experimental Biology on the Berkeley campus, which was a major center for vitamin and hormone research. Bennett then matriculated in the medical school and completed his training in 1942, when he joined the faculty and continued his research interests in pituitary and adrenal function, as well as cardiovascular function.

Ogden left the department in 1943 to become Professor of Physiology in the University of Texas medical school, and Leo A. Sapirstein was appointed Instructor in Physiology as his replacement for one year. Sapirstein had just received his Ph.D. under the tutelage of Ogden, and after the year on the department faculty he went on to medical school in San Francisco and ultimately to rejoin Ogden for an academic career at Ohio State University.

Sapirstein was replaced as Instructor in Physiology by D. Harold Copp in 1944. Copp, born in Toronto, received his A.B. and M.D. degrees from the University of Toronto and then came to Berkeley to earn a Ph.D. in biochemistry in 1943. He became involved in research with the Radiation Laboratory on fission product metabolism that eventually led to his substantial contributions on the regulation of calcium and bone metabolism. Copp also revived the course on the physiology of growth and development in the child, which had not been offered since Shock's departure in 1941.

Also in 1944 Cecil Entenman was appointed Instructor in Physiology. Entenman received his Ph.D. in physiology under Chaikoff in 1940 and remained in Chaikoff's laboratory in a postdoctoral capacity engaged in lipid metabolism research until he received a faculty appointment. Entenman continued an active program of research in lipid metabolism, but in 1949 he resigned from the faculty to join the new U.S. Naval Radiological Defense Laboratory in San Francisco as a civilian scientist.

The end of World War II signaled the beginning of the new era of massive federal support for higher education and academic research in the form of passage of the G.I. Bill, the creation of the Office of Naval Research, the Atomic Energy Commission, and the National Science Foundation, and the enormous expansion of the National Institutes of Health. Berkeley was no exception to the remarkable surge of growth undergone by institutions of higher learning generally, as shown by the fact that in 1945 the total student population was 11,000, of whom 3,500 were graduate students, while in 1946 total students had jumped to 22,000, of whom 12,000 were graduate students.

Hardin B. Jones was added to the department faculty in 1946 as Instructor in Physiology under a joint appointment with the Division of Medical Physics, then a part of the Department of Physics. Jones, a native of Los Angeles, had received his A.B. degree from the University of California, Los Angeles in 1937 before coming to Berkeley to earn his Ph.D. in physiology under Chaikoff in 1944 and had become involved with inert gas exchange research at the Donner Laboratory. He pioneered a course on the physiological effects of ionizing radiation and became Assistant Director of the Donner Laboratory in 1948. He went on to serve both the Department of Physiology and the Department of Medical Physics for 30 more years until his death from coronary heart disease in February 1978 at age 63. Among his many scientific contributions Jones established that inert gas exchange depends on blood flow, and his rigorous analyses of the epidemiology of cancer, atherosclerosis, and degenerative diseases led to a theory of aging that has permitted quantification of human longevity. He spent the last part of his career examining the problem of drug abuse and was an ardent spokesman against drug use.

Nello Pace joined the department as Assistant Professor of Physiology in 1948 and was given the task of reinstituting the course in general physiology and structuring a new course in environmental physiology. Pace, born in California, received his B.S. from Berkeley in 1936 and the Ph.D. in physiology from Berkeley in 1940 under the tutelage first of Blum until his departure in 1938 and then of Cook. After a postdoctoral year at the Medical College of Virginia he was called to active duty with the U.S. Naval Reserve in the summer of 1941 and assigned to work with Albert R. Behnke in developing the Naval Medical Research Institute in Bethesda, Maryland; the war years were spent investigating a wide range of environmental physiological problems from high altitude to deep-sea diving. Pace returned to Berkeley in 1946 as a research associate in medical physics at the Donner Laboratory until receiving his appointment in Physiology and continuing the departmental lineage from Loeb to Maxwell to Blum. His most recent research has been in gravitational physiology.

Benjamin Libet was appointed Assistant Professor of Physiology in 1949 to take over the departmental teaching of neurophysiology from Olmsted. Libet, a native of Chicago, received his Ph.D. in physiology at the University of Chicago in 1939 and served as an instructor at Albany Medical College and the University of Pennsylvania before working with the Air Corps at Wright Field during World War II. He returned to the University of Chicago as Assistant Professor of Physiology from 1945 to 1948 and then was appointed staff physiologist at the Kabat-Kaiser Institute for a year before joining the department.

In 1950 Pace established the White Mountain Research Station near Bishop, California as a university facility for conducting high-altitude research at elevations of 1,250–4,340 meters. It should be noted that the bulk of the construction of the various laboratory sites was carried out with the collaboration of university colleagues Sherburne F. Cook, Ralph H. Kellogg, and Arthur H. Smith, plus several dozen graduate students, all of whom practiced environmental physiology as well as preached it. Pace served as Director of the facility until his retirement from the faculty in 1977.

Throughout the war years and during the postwar resurgence of the department Olmsted kept a steady hand on its administration. He gradually developed a keen interest in the history of ideas in physiology since the 1930s, and by 1952 he published definitive biographies of Claude Bernard, Bell-Magendie, and Brown-Séquard. As a result, he acquired stature not only as a neurophysiologist but also as a historical scholar.

Olmsted relinquished the chairmanship of the department to Leslie Bennett in 1953, a year before his retirement, and in that year Ralph Kellogg joined the faculty as Assistant Professor of Physiology. Kellogg, born in Connecticut, received his M.D. degree from the University of Rochester in 1943 and entered the Navy. He spent his last tour at the Naval Medical Research Institute with Pace, and after the war he earned his Ph.D. degree in physiology at the Harvard Medical School in 1953. When he joined the Berkeley faculty his research interests were in renal water and electrolyte balance; however, Kellogg could not resist the temptations of research on high-altitude respiratory function and went on to make a number of significant contributions and become a recognized authority in this field.

Medical Physiology Returns to San Francisco

By 1955 it became evident that a regental decision had been reached to return the teaching of the first year of the medical curriculum from Berkeley to San Francisco. Cook, Jones, and Pace were not involved in the teaching of the medical physiology course and remained in Berkeley; Chaikoff also decided to remain in Berkeley, under a departmental budget to come from the College of Letters and Science rather than the School of Medicine.

Bennett was authorized to add two more faculty to the Department in preparation for the move to San Francisco with a full instructional cadre. Thus, in 1955 William Francis Ganong was appointed Assistant Professor of Physiology and Adrienne Applegarth Batts was named Instructor in Physiology. Ganong, born in Massachusetts, received his medical training at Harvard Medical School by 1951 and then remained to become Director of the Surgical Research Laboratory by 1955. He came to Berkeley with a budding reputation in neuroendocrinology that has continued to flourish since, as has his classic textbook *Medical Physiology*. Batts, a San Francisco native, received her A.B. from Berkeley and her M.D. from Harvard before returning to Berkeley to earn her Ph.D. in physiology under the guidance of Bennett in 1953. She then served as Associate in Physiology, doing research on the regulation of secretion from the islets of Langerhans before receiving faculty status.

The fission of the department was effected in 1958 to complete the move of the entire first year of the medical curriculum to new quarters on the San Francisco campus of the university. Bennett went as chairman and was accompanied by Libet, Kellogg, Ganong, and Batts. A similar splitting of the Department of Anatomy occurred at the same time, leaving a contingent in Berkeley.

Physiology and Anatomy Merge

The administration of the College of Letters and Science decreed that a joint Department of Anatomy and Physiology was to be created with Cook as Co-chairman for Physiology and C. Willet Asling, Professor of Anatomy, as Cochairman for Anatomy, with separate budgets for each moiety. Asling received his M.D. from the University of Kansas in 1939, and after teaching anatomy at Vanderbilt University and the University of Kansas medical schools during the war, he came to Berkeley to enter the Ph.D. curriculum in anatomy. On receiving his degree in 1947 he was appointed Assistant Professor of Anatomy. His research on the control of skeletal development and in the field of teratology has led to notable contributions.

Cook had been allowed one more Physiology faculty position for 1958; thus Paola S. Timiras was named Assistant Professor of Physiology. Timiras, a native of Rome, received her M.D. from the University of Rome in 1948 and her Ph.D. in experimental medicine and surgery under Hans Selye at the University of Montreal in 1953. She then served as Assistant Professor of Pharmacology at the University of Utah in Salt Lake until coming to Berkeley as Assistant Research Physiologist with Pace from 1955 to 1958, when she joined the faculty. She was given primary responsibility for organizing and teaching the replacement mammalian physiology course to fill the large curricular gap left by the departure of the San Francisco group. Her outstanding success in this crucial task was matched only by her vigorous pursuit of a major research program in neuroendocrinology, environment physiology, and developmental physiology, which continues to this day. She received the 1985 Research Award from the American Aging Association.

An uneasy period of adjustment ensued for the new combined Department of Anatomy and Physiology. Separate course listings and graduate degree curricula were kept in the two fields, and minor budgetary overlaps had to be resolved. However, difficulty persisted in formulating a coherent departmental planning policy because of the dual chairmanship.

At the same time the path of physiology itself steadily became smoother. The bulk of the laboratory teaching equipment for mammalian physiology had been taken to San Francisco, having been purchased from medical school funds, so that Berkeley was left with very few kymographs and inductoriums, for example. Thus, Cook was able to obtain College of Letters and Science funds to replace the laboratory equipment, and adversity was turned to advantage by the purchase of modern electronic instrumentation and ink writers for the students.

The Berkeley administration also recognized the fact that while the medical physiology course was no longer being taught, the equivalent academic mammalian physiology course still needed to continue along with the other physiology course offerings—all this with half the previous number of faculty. Thus, Cook was able to get approval for the addition of three new faculty members to start a growth phase for the department, which has continued to the present.

In 1959 Walter J. Freeman III was appointed Assistant Professor of Physiology to bolster the teaching in neurophysiology. Freeman, born in Washington, D.C., received his M.D. from Yale in 1954, and after a year of internship at John Hopkins he took a position as Assistant Research Physiologist in the Brain Research Institute at the University of California, Los Angeles; from there he came to Berkeley. His research has involved the correlation of bioelectric potential patterns of neuropopulations in the central nervous system with animal behavior so as to provide insight into the phenomenon of complex neural information processing.

Freeman's appointment was followed by that of Robert I. Macey as Assistant Professor of Physiology in 1960. Macey, a native of Minneapolis, received his Ph.D. in mathematical biology from the University of Chicago in 1954. After a year at the Illinois Institute of Technology as Instructor in Mathematics, he took a position as Associate Research Physiologist with the Aeromedical Laboratory of the University of Illinois from 1955 to 1957 before serving as Assistant Professor of Physiology in the College of Medicine there from 1957 to 1960. On coming to Berkeley he took over the large introductory physiology course from Cook. Macey's primary research interests have been in the fields of theoretical biophysics and membrane transport, to which he has made outstanding contributions.

Lester Packer was the next to join the department when he was appointed Assistant Professor of Physiology in 1961. He was born in New York and completed his Ph.D. in microbiology at Yale in 1956. He then did postdoctoral work at the Johnson Foundation for Medical Physics and Dartmouth Medical School before serving as Assistant Professor of Microbiology at the Texas Southwestern Medical School from 1960 to 1961. Packer assumed the responsibility for teaching the general physiology course from Pace and continued his productive research investigations on mitochondrial bioenergetics, which have led to a theory of aging.

During this period several new physiology courses were added to the department offerings. In 1959 Timiras expanded the traditional undergraduate course on the physiology of growth and development in the child into a course on human development from conception to old age. Then in 1960 Timiras pioneered a graduate course on the physiological action of drugs and Freeman developed a graduate course in neurophysiology. In 1961 Pace instituted a graduate course in space physiology, followed in 1963 by the introduction of a graduate course on physiological transport processes given by Macey.

Meanwhile, the anatomy component of the dual department maintained a steady level. Besides Asling, the initial 1958 faculty comprised Miriam E. Simpson, Professor of Anatomy, Edward S. Evans, Assistant Professor of Anatomy, and Herbert H. Srebnik, Instructor in Anatomy. Simpson, a native of Wyoming, received her Ph.D. in anatomy from Berkeley in 1921 under the tutelage of Herbert M. Evans and then earned the M.D. from Johns Hopkins University in 1923. She returned to Berkeley as Instructor in Anatomy in that year and remained on the faculty until her retirement in 1961. She also served as Director of the Institute of Experimental Biology from 1956 to 1960, when it was phased out. Her research in hematology, the physiology of the anterior pituitary, and sex physiology produced numerous contributions in the course of her long and success-

ful career in the university. Her retirement marked the end of an important historical era for anatomy in Berkeley.

Edward S. Evans, an Oregon native, earned his A.B. and his Ph.D. in endocrinology from Berkeley by 1956, when he was appointed Instructor in Anatomy. In 1958 he assumed primary responsibility for teaching the course in histology and microscopic organology, which he continued until his unexpected and untimely death at age 46 from a coronary attack in December 1972. He was a superb teacher with research interests in pituitary and thyroidal metabolic interactions that, among other significant contributions, led to an explanation of the phenomenon of extrathyroidal iodothyronine production.

Srebnik was born in Berlin and served in the British Royal Air Force from 1943 to 1946. He received his A.B., M.A., and Ph.D. in anatomy from Berkeley by 1957 and became Instructor in Anatomy. In 1958 he took responsibility for the advanced course in systematic and regional human anatomy, which he teaches today. As was the case with Timiras in physiology, Srebnik in exemplary fashion filled a large curricular gap in anatomy left by the move of part of that department to San Francisco. His productive research activities have addressed endocrine-nutrition relationships involved in anterior pituitary function and the physiology of reproduction. Srebnik is the senior member in point of service on the currently active department faculty.

In Full Flood

The final step in the marriage of anatomy and physiology in Berkeley occurred in 1964 when S. F. Cook retired. At that point the administration of the College of Letters and Science decided to merge the two budgetary units into a single Department of Physiology-Anatomy, and Pace was named Chairman of the new entity, with Asling as Vice-Chairman. However, separate designations were retained for courses in the two disciplines, as were the advanced degree curricula. Thus the department presently continues to offer student programs leading to the A.B., M.A., or Ph.D. in physiology and to the M.A. or Ph.D. in anatomy.

The consolidation did provide the opportunity for modernization of the administrative support for the department, and a transition from the traditional department secretary to a professional department business officer was made in 1964. Physiology-Anatomy was one of the first in Berkeley to alleviate the problems engendered by the burgeoning bureaucracies of both the university itself and the federal funding agencies in this fashion. Germano A. Corazza, Management Services Officer, has served the department since 1966, and he and his staff deserve the highest praise for their outstanding performance in support of the teaching and research responsibilities.

In 1965 Asling transferred from Berkeley to the San Francisco campus, and Marian C. Diamond was added to the faculty as Assistant Professor of anatomy. Diamond, a native of California, received the A.B., M.A., and Ph.D. in anatomy at Berkeley by 1953, and after several years as Instructor in Anatomy at Cornell University returned to serve as Lecturer in Anatomy in San Francisco from 1959 to 1961. She was appointed Associate Research Anatomist in the Institute of Experimental Biology in Berkeley in 1961 and took over the teaching of neuroanatomy from Asling in 1962. Diamond developed a collaborative research program with psychologist Mark R. Rosenzweig of Berkeley to study environmentally induced anatomical and chemical brain changes in rats, which has produced important results and which she continues to pursue independently and successfully.

Also in 1965 Lawson L. Rosenberg was appointed Associate Professor of Physiology. Rosenberg, born in Maryland, received the Ph.D. in physiological chemistry from Johns Hopkins University in 1951 and served as Instructor in Pediatrics there until coming to Berkeley in 1953 to join the staff of the Institute of Experimental Biology. His research on pituitary hormones and their relationships to target organs, particularly his meticulous experiments on the regulation of thyroid function, has won him wide acclaim. Thus, in 1965 when he joined the faculty he was able to take over the teaching responsibilities in endocrinology being relinquished by Chaikoff because of failing health and continues to meet those responsibilities today.

By 1965 the Berkeley student population had grown to 27,000 total students, of whom 10,000 were graduate students. In the decade 1945–55, 49 Ph.D. degrees in physiology had been granted, and in the decade 1955–65, 37 were awarded despite the sharp reduction in number of Physiology faculty as a consequence of the move of the first year of the medical curriculum to San Francisco in 1958.

Because of the ever-growing teaching load on the department, Pace was able to obtain three more faculty positions, and in 1965 John G. Forte was appointed Assistant Professor of Physiology to share the teaching responsibility for introductory physiology and the advanced mammalian physiology courses. Forte, a native of Philadelphia, received his Ph.D. in physiology from the University of Pennsylvania in 1961 and then spent three postdoctoral years there and one more postdoctoral year at the University of Southern California before coming to Berkeley. Forte's research has centered on the secretory mechanisms of the glandular systems of the gastrointestinal tract, and one of his most important contributions has been an explanation of the precise nature of the proton pump of the oxyntic cells of the gastric mucosa. For this he received the 1985 William Beaumont Prize from the American Gastroenterological Association.

In 1966 Charles S. Nicoll joined the department as Assistant Professor of Physiology to take responsibility for the comparative physiology courses, which had been in abeyance since Cook's retirement in 1964. Nicoll, born in Toronto, earned his Ph.D. in physiology from Michigan State University in 1962 and spent three postdoctoral years in Berkeley with Howard Bern in the Department of Zoology. He spent two more years at the National Cancer Institute in Bethesda, Maryland before returning to Berkeley as a faculty member in Physiology. His productive research interests have lain in the areas of growth regulation and of mammary and pituitary physiology, with particular emphasis on the comparative aspects of prolactin function.

Another significant addition to the department offer-

ings was made in 1966 by the introduction of a course on developmental anatomy by Srebnik and Evans. A classic course on embryology had been taught for many years in the Department of Zoology but was given for the last time in 1965. The Physiology-Anatomy course continues to be given to this day by Srebnik.

In 1967 Peter Satir was appointed Associate Professor of Anatomy to bring the strengths of electron microscopy and modern cell biology to the department. Satir, a native of New York, received his Ph.D. from the Rockefeller Institute in 1961 and immediately joined the faculty in biology and zoology at the University of Chicago, where he remained until coming to Berkeley. His research contributions to the structural and functional bases for ciliary motility have been outstanding, and his introduction of an advanced course on the molecular, physiological, and evolutionary determinants of cell and tissue fine structure represented a significant expansion of the anatomy curriculum.

By this time the principle of regular rotation of department chairmen had been adopted in Berkeley, supplanting the older concept of the chair for life. With Physiology-Anatomy now stabilized administratively, Pace was pleased to turn over the chairmanship to Freeman in 1967.

Shifting Currents

However, major stirrings had developed on the campus over the prospect of great new advances in neurobiology, and a departmental decision, not unanimous, was reached to change the emphasis from a balanced department to a "center of excellence" in this narrower aspect of physiology. As a first step, Horace B. Barlow and Gerald Westheimer, both distinguished Professors of Physiological Optics and Optometry in the School of Optometry, elected to transfer to Physiology-Anatomy as Professors of Physiology in 1968. In addition, two new faculty positions were allocated to the department by the university administration to increase the strength in neurobiology still further.

Barlow, born in England, received his B.A. from Cambridge in 1943, the M.D. from Harvard in 1946, and medical degrees from Cambridge in 1947, where he remained as Lecturer and Fellow in Physiology until 1964. In that year he was Professor of Physiological Optics and Optometry at Berkeley, until moving to Physiology-Anatomy in 1968. He instituted a course on the physiology of sensation in the department in 1966, and he pursued his highly regarded research on the physiology of vision and the coding of sensory information. When he joined Physiology-Anatomy, he promptly collaborated with Freeman and Nicoll to institute two graduate courses on neurobiology and relinquished his former course on the physiology of sensation.

Westheimer, a native of Berlin, received his B.Sc. from the University of Sydney in 1947 and the Ph.D. in physics from Ohio State University in 1953. He served as Professor of Physiological Optics at the University of Houston for a year and then returned to Ohio State University as Assistant Professor of Physiological Optics, where he remained until coming to Berkeley as Associate Professor of Physiological Optics and Optometry in 1964. On his transfer to Physiology-Anatomy in 1968, Westheimer developed a general undergraduate course in neurobiology and has continued to pursue his highly acclaimed research on the biophysics and physiology of the visual system as attested by his election to the Royal Society of London in 1985.

The two new positions went to Michael F. Land and Alan B. Steinbach, who were appointed Assistant Professors of Physiology in 1969. Land, also a native of England, received his Ph.D. in physiology from University College of London in 1967 and then came to Berkeley on a Miller Institute fellowship for two years before joining the faculty. For his thesis research he showed that the eye of the scallop forms an image by reflection rather than refraction and in Berkeley turned his attention to a study of the role of vision in the behavior of the jumping spider.

Steinbach, born in New York, was the son of Henry Burr Steinbach; he received his Ph.D. in biophysics from Rockefeller University in 1967. Before coming to Berkeley he spent a year in postdoctoral work at University College of London and another one in physiology at the Albert Einstein College of Medicine in New York. His promising research was on the molecular physiology of chemical excitation and on trophic effects of nerve on muscle.

When Land and Steinbach joined the department they replaced Freeman and Nicoll in teaching the graduate neurobiology courses and, with Barlow, the sequence was increased to three courses. In addition, Timiras and Nicoll introduced a graduate course in neuroendocrinology. Thus a substantial curriculum in neurobiology had rapidly been structured. For good measure, in 1970 Land and Steinbach introduced a general course on the biology of man for students not majoring in the biological sciences, which complemented the course on introductory physiology.

However, a sea change occurred in 1971 with the departure of Land from Berkeley to return to England, followed by the departure of Steinbach in 1972 to enter medical school. In 1972 the graduate courses in neurobiology under Barlow's aegis were transferred to a new teaching entity termed "interdepartmental studies," which has since served as the forum for neurobiology on the campus. Barlow left Berkeley for England in 1974, and with him went much of the momentum for the dominance of neurobiology in the department. However, a solid survivor from this era is the graduate course in neuroendocrinology still being ably taught by Timiras and Nicoll. Also, the general course on the biology of humans has remained popular and has been taught by Freeman since 1975.

In 1972 Forte replaced Freeman as chairman, and there followed a gradual reordering of departmental goals toward a tripartite emphasis on cell physiology, endocrinology, and neurophysiology. A step in this direction was taken in 1973 by the appointment of Robert S. Zucker as Assistant Professor of Physiology. Zucker, a native of Philadelphia, received his S.B. at the Massachusetts Institute of Technology in 1966 and his Ph.D. in neurological sciences at Stanford University in 1971. He then did postdoctoral work in biophysics at University College in London and in the Cellular Neurobiology Laboratory of France before joining the department. Zucker's research interests are in excitable membrane biophysics and in egg fertilization and activation. He has recently published a landmark paper on the role of calcium in synaptic trans-

mission, and he is actively involved in the teaching of the core course in cellular and neural physiology.

Mary Beth Burnside was appointed Assistant Professor of Anatomy in 1975 to fill the gap left by the demise of Evans and in 1976 activated a course in histophysiology. Burnside, born in San Antonio, received her B.A., M.A., and Ph.D. in zoology from the University of Texas by 1968. She was Instructor in Anatomy at Harvard Medical School from 1971 to 1972 and then served as Assistant Professor of Anatomy at the University of Pennsylvania until coming to Berkeley. Her productive research has been on the mechanisms involved in changes of cell shape, and in 1983 she received the additional distinction of being appointed Dean of Biological Sciences in the College of Letters and Science.

Terry E. Machen received his appointment as Assistant Professor of Physiology in 1975 after having served as Lecturer in Physiology for a year. Machen, a native of California, received his B.A. from the University of California, Santa Barbara in 1967 and his Ph.D. in physiology in 1971 from the University of California, Los Angeles. After postdoctoral work at the Agricultural Research Council Institute for Animal Physiology in Cambridge, England and at Saarland University in Hamburg, he came to Berkeley for additional postdoctoral work with Forte in 1973. His research has centered on the mechanisms of active ion and water transport across cell membranes, particularly of the gastric mucosa, the urinary bladder of fish, and the gall bladder, and his contributions have been numerous.

Pace retired from the faculty in 1977 and, although Timiras still maintains an active research interest in environmental physiology, formal course work in this area was brought to a close. The decision to do so was part of a trend in the department to seek to emphasize the reductionist approach to physiology over the integrative and holistic approach.

In 1978 Timiras assumed the chairmanship from Forte, and in 1979 Jeffery A. Winer joined the department as Assistant Professor of Anatomy to assume responsibility for teaching the neuroanatomy course. Winer, born in Minneapolis, received his Ph.D. in physiological psychology from the University of Tennessee in 1974. After two years of postdoctoral work in neuroanatomy at Duke University, a year at Harvard Medical School, and two more years at the University of Connecticut he came to Berkeley. Winer's extensive research has been on the neuroanatomy of the central auditory and visual systems, a field in which he has made significant contributions.

Roger Y. Tsien was appointed Assistant Professor of Physiology in 1981. Tsien, a native of New Jersey, received his A.B. from Harvard University in 1972 and his Ph.D. in physiology in 1978 from the University of Cambridge. He remained in the Physiological Laboratory at Cambridge in a postdoctoral capacity until joining the Berkeley faculty. Tsien, a Searle Scholar since 1983, has pioneered in the development of ion-selective microelectrodes and fluorescent probes for making intracellular measurements of ion activities, particularly calcium. His application of these techniques is resulting in a major expansion of understanding of the role of ions in cell function.

In 1983 Gary L. Firestone was added to the department as Assistant Professor of Physiology. Firestone was born in Pennsylvania and received the B.A. from Bucknell University in 1974 and his Ph.D. in biochemistry from the University of Iowa in 1980. He spent three years as a postdoctoral fellow in the Department of Biochemistry and Biophysics at the University of California, San Francisco before coming to Berkeley. He received a five-year National Science Foundation Presidential Young Investigator Award, and his important research in glucocorticoid regulation of cellular protein processing and compartmentalization has received wide attention.

Macey took over as chairman from Timiras in 1984, and in 1985 Hsiao-Ping Hsu Moore became the most recent addition to the department faculty when she was appointed Assistant Professor of Physiology. Moore, a native of Taiwan, received the B.S. from the National Taiwan University in Taipei in 1975 and her Ph.D. in chemistry from the California Institute of Technology in 1980. After a year of postdoctoral work there she spent four more years of postdoctoral work, like Firestone, in the Department of Biochemistry and Biophysics at the University of California, San Francisco until she came to Berkeley. Her investigations of the functional role of acetylcholine receptors in the electric organs of rays and eels have yielded important new findings.

The Department of Physiology-Anatomy today comprises 17 regular faculty members, of whom 13 are nominally designated in physiology and 4 in anatomy. Some 25 undergraduate and 9 graduate lecture and laboratory courses are offered, together with 13 graduate seminar courses and various self-study and independent research courses. In the past year a total of 3,255 students enrolled in the department course offerings. Currently there are 135 undergraduates declared as physiology majors, and 53 graduate students in the department as a whole. Of them, 37 are pursuing the curriculum in physiology and 5 in anatomy, while 7 are in the group field of endocrinology, 2 in biophysics, and 2 in comparative biochemistry. During the 1965–75 decade, 54 Ph.D. degrees were awarded in physiology per se and 51 were awarded during 1975–85; 235 Ph.D. degrees in physiology have been granted in Berkeley between 1905 and 1985.

These statistics may be projected against those for the Berkeley campus as a whole, which now boasts 22,321 undergraduate and 9,161 graduate students for a total student population of 31,482. Thus, it might appear that physiology is alive and well in Berkeley as a respected academic discipline.

Reefs and Shoals

It is sad to relate, however, that storm clouds of punctuative change loom over biology in Berkeley that threaten the existence of the traditional biological departments. They began to gather in 1973 when a few influential, and undoubtedly well-intentioned, faculty suggested to the university administration that "Berkeley was not geared up to participate in the exciting developments occurring in genetics and molecular biology." The administration seized on the suggestion, and a succession of committees has since produced a plan to dismantle the existing biology departments and restructure their faculty into affinity groups so as to transform the academic structure into that of a biolog-

ical research institute structure with constellations of "superstars." Proposed trendy designations for the affinity groups might be titles like "cell and developmental biology," "molecular biology," "plant biology," and "evolutionary and ecological biology." Once the reshuffle has occurred, it has been suggested that then the new departments will begin deciding what kind of curricula they wish to offer.

One can only trust that this radical evolutionary step, scheduled to occur in the next few years, will not suffer the fate of the recent theory of punctuated equilibrium. Certainly the tide of physiology is turning once again in Berkeley. Let us hope that it may continue to cycle in support of the organism as a whole during the second century of APS.

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History of Physiology Department at University of British Columbia

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Soon after British Columbia joined Canada in 1871, there were discussions about setting up a provincial university. In 1890, the provincial legislature passed an act to establish a University of British Columbia with faculties of Arts, Law, Medicine, and Science. The project failed because of the rivalry between Victoria and Vancouver for the campus site and the failure of a quorum to appear for the first meeting of the university senate. This act was repealed in 1908 and replaced by the act that was, with amendments, to govern the University of BC for the next 55 years. In 1910, land was set aside at the tip of Point Grey for the permanent campus, now grown to 1,000 acres. With its sweeping views of sea and mountains, it is one of the most magnificent university sites in the world (as delegates to the very successful XXX Congress of the International Union of Physiological Sciences saw when they were in Vancouver in July 1986). In 1912, funds were voted for capital construction on this site and work was begun on a science building in 1914. World War I brought an abrupt stop to these activities; the first classes commenced in 1915 in the shacks previously used by McGill College of BC on the Fairview slopes adjacent to the Vancouver General Hospital. The initial enrollment was 379. After the war there was increasing pressure to build the university at Point Grey. A massive campaign in 1922 culminated in the "Great Trek" to this campus and the half-finished Science Building. The legislature responded promptly by making a grant of $1.5 million for capital construction, and classes moved to the permanent campus in 1925. During the Depression years, the university budget was slashed and there was even talk of closure.

However, it survived these years and World War II and was prepared for the onslaught of veterans when peace arrived (4). The new president, Norman (Larry) McKenzie, was well prepared for the challenge and, with the help of Gordon Shrum, arranged for abandoned army huts to be uprooted and transported to the campus (without waiting for approval by the bureaucrats in Ottawa). These provided classrooms, laboratories, and living quarters for the new students and faculty. There was increasing pressure from the BC Medical Association and from the student veterans to establish a Medical School, and in 1945 the legislature approved a capital grant of $1.5 million for this purpose. Claude Dolman was appointed by the university to make a survey of the leading medical schools in the United States and Canada, and in his comprehensive report (3) submitted May 10, 1946, he recommended the establishment of a unified medical school on campus, including a teaching hospital. This report drew strong criticism from the downtown physicians and the BC Medical Association, and a counterreport was prepared by G. F. Strong (6), suggesting that the school be located adjacent to the Vancouver General Hospital. An international committee of leading medical educators was set up under the chairmanship of R. F. Farqharson to review the situation, and in a report submitted July 9, 1946, the committee strongly endorsed the Dolman report.

In reponse to one of the recommendations in this report, approval was given to the use of the capital funds for construction of an Institute of Preventive Medicine (the Wesbrook Building), which opened in 1952. This unfortunately left nothing for the prospective Faculty of Medicine. In 1948, the Minister of Education approved the establishment of the Medical School, and in 1949, Myron M. Weaver (then Assistant Dean of Medicine at Minnesota) was appointed as the first Dean. He was a physiologist, as have been three of his four successors. He set up shop in the walled-off end of a corridor in Dr. Shrum's new Physics Building and proceeded to recruit faculty. Because funds for construction had been assigned to the Wesbrook Building, the new school had to make do with a group of huts that had been vacated by the Department of Civil Engineering. Physiology and Pharmacology shared 6,000 square feet at the south end of hut B-6, while Anatomy occupied similar space at the north end. It was in a laboratory in this hut that we discovered calcitonin in 1960.

Possibly because I was a Canadian and had graduated with the gold medal from the Faculty of Medicine of the University of Toronto, I was asked if I would be interested in heading the Department of Physiology in the new school. I was flattered and intrigued. At the time, I was an Assistant Professor in the Physiology Department at the University of California, Berkeley, and had as my major responsibility the running of the medical student laboratory. It was experience that

Huts housing UBC Medical School from 1950 to 1961. *Arrow* indicates location of Physiology/Pharmacology end of Hut B-6.

served me in good stead in the years ahead. I stopped in Vancouver for interviews on my way back from Christmas with my family in Toronto. I was impressed by Dean Weaver and particularly by President MacKenzie, who was living in a converted army hut as were the students and new faculty. In January 1950 I was offered the job but found the decision difficult because of my genuine affection for California and my colleagues there. The balance was tipped by the surrender of the faculty at California to the imposition of the special Loyalty Oath—a condition that as a Canadian and an academic, I found repulsive. I happily phoned Dean Weaver to indicate my acceptance. It was undoubtedly the most important career decision I have ever made.

Early Years: 1950–1961

In the spring of 1950, Dean Weaver persuaded Edgar C. Black to leave the Zoology Department at UBC, where he had been teaching mammalian physiology, to join the new medical school as the first faculty member in the Department of Physiology. Dr. Black had trained under Lawrence Irving and received his Ph.D. from the University of Pennsylvania in 1940. He returned to Canada that year to work with Sir Frederick Banting's group on the development of a demand oxygen mask for flyers. In recognition of this work he was made a Member of the Order of the British Empire (MBE) in 1943. A dour Scot, he had a deep sense of integrity, lightened by a delightful, dry sense of humor. Seven years my senior, I am sure there were occasions when he felt that he might have made a better head. There were times when he would mutter misgivings about "that young whippersnapper from California." I came to appreciate him as a friend and colleague. He was an excellent, if unusual, teacher (he believed in the Socratic method) and was highly respected for his research on respiration and effects of exercise in bony fishes. His untimely death in 1967 was a great loss to the Department.

I arrived in Vancouver with my family on September 5, 1950 (Labor Day), and after settling them in a one-bedroom army hut in Wesbrook Place, fondly referred to as Shrum's slum, I hastened over to the Department to see Dr. Black and to check on the supplies I had ordered. I found the shelves as bare as Mother Hubbard's cupboard—there was not even a test tube. Because 60 medical students were registering the next day, I quickly explained the situation to Dean Weaver and asked for a six-week delay before starting instruction in physiology. He gladly agreed. The delay proved to have some advantages, for it meant that our students had some experience with the anatomy of the thorax and abdomen before being introduced to cardiorespiratory and intestinal physiology. My major concern was the delivery of the smoked-drum kymographs that, at that time, were essential for any laboratory work in physiology. When I cabled the Palmer Company about our order they promised delivery in two years. I shot back a cable demanding that they deliver in six months or cancel the order. They delivered.

Left: Edgar C. Black, first member of Physiology faculty; *right:* D. Harold Copp, first head of Physiology Department (1950).

Meantime, I canvassed my friends in Canadian Departments of Physiology and finally found a stock of old Harvard kymographs at the University of Toronto that Reg Haist sent to us on loan. The other supplies were easy, thanks to the efforts of Alan LeMarquand and Gene McLintock in our purchasing department. Meantime, I took advantage of the postponement to visit a number of the leading North American departments to learn more about the organization and teaching of physiology. On my travels (by train), I was allowed $6 per day for hotels and $6 for meals and incidentals. It was an exciting trip, and I met many of the great leaders of physiology of that time—Maurice Visscher (Minnesota), John Fulton and C. N. H. Long (Yale), Homer Smith (New York University), Wallace Fenn (Rochester), Eugene Landis (Harvard), Hank McIntosh (McGill), and Charles Best (Toronto).

I returned to find that the equipment had arrived and we were prepared to welcome the 60 first-year medical students—mostly veterans (some older than I). For the next few months, I gave the lectures, prepared the lab outlines, set up the laboratory, and served as secretary, technician, and demonstrator. The university motto "Tuum Est" (freely translated: "it's up to you") seemed particularly appropriate. The laboratory course (12 hours a week) naturally leaned heavily on my experience at California and included a number of experiments on dogs. My first move was to approach David Ricardo, executive director of the Vancouver Society for Prevention of Cruelty to Animals (SPCA). He agreed that the SPCA would not oppose our request to City Council to purchase unclaimed pound dogs, on the condition that they would be well treated, anesthetized fully, and killed painlessly after the experiment. I, in turn, invited Dave to come to the Department at any time unannounced and to talk to the class about the humane care of animals. The good relations between the Department and the SPCA have continued to this day, and there is currently a joint research project sponsored by the university and the SPCA, in which members of the department are studying certain viable substitutes for the use of intact animals in medical research.

With the opening of the spring term, James G. Foulks was appointed Head of Pharmacology and together we hired and shared a secretary (Muriel Henderson), technician (Gerrie Kent), and shop man (Howie Ayers). I persuaded William C. Gibson (Sherrington's last graduate student) to give the lectures in neurophysiology. Somehow, I survived, and the first year went very well.

The next year was much easier, and I had time to devote to my research studies on calcium homeostasis with the aid of a grant ($8,500) from the Associate Committee on Medical Research of the National Research Council of Canada—support that has continued up to the present. I was now able to turn my attention to the Department's responsibility to aspiring physiologists. A hastily prepared brief recommending a graduate program was rejected by the University Senate, in part because of opposition from the physiologists in the Zoology Department. I enlisted their help in preparing a much more comprehensive brief, and this time our proposal, seconded by Dr. Hutchinson, Head of Biology, was approved unanimously by the Senate. The calendar listed a Master's program in 1952–53, a Ph.D. program in 1953–54, and an Honours program in 1955–56. However, listing did not guarantee students. Our first graduate was Sydney Segal, M.D., who received an M.A. in physiology in 1954 with a thesis on respiration in premature rat fetuses. He went on to head the premature infant unit at the Health Centre for Children in Vancouver and recently retired as Professor of Paediatrics. Our first Honours student, Alice P. Suiker, received her B.A. in 1955 and her M.A. in 1956. She went on to take her M.D. at UBC and is currently engaged in family practice in Duncan, BC. Our first Ph.D. was obtained by Sun Shik Shim, M.D., in 1965 for studies on bone blood flow. Dr. Shim is now head of the Department of Orthopedic Surgery at the Health Sciences Centre of the University of BC.

In the absence of graduate students, medical students were recruited to work as research assistants in the summer months—a practice that was encouraged by the requirement in those days of a research thesis for the M.D. degree at UBC. My own research program, which led to the discovery of calcitonin in 1960, was greatly facilitated by such students as E. C. Cameron, J. M. Frederickson, B. DeJong, G. F. Davidson, and W. J. Dube.

In 1952, on the advice of Hank McIntosh, I recruited John Honour, who had worked closely with Sir Thomas Lewis at University College, London, and wished to try his hand in Canada. He brought to the Department his great wealth of technical and laboratory experience and, although he returned to England two years later, he was back as an instructor in 1957. He finally left to join Sir George Pickering's department at Oxford in August 1959. Howeever, John still maintains his ties with the department and his affection for it. It was during this period that I met Kurt Henze, who was conducting a dog training course in Stanley Park. I was so impressed with the way that he handled the dogs and their owners that I offered him a job as a junior technician March 1, 1954. It was one of my most fortunate appointments as head of the department. With John Honour's guidance, he quickly mastered the details of equipment use and animal experimentation, and when Honour left August 1, 1954, Kurt became Head Technician. Over the years, with the able assistance of Ralf Assinna, he was responsible for the very efficient technical operation of the Department and its excellent rapport with the service departments of the university, which always responded promptly to his requests. His contributions to my own research work on calcitonin have been equally invaluable. He was a key figure in the Department, and for many years the faculty would gather in his storeroom on Friday afternoons for a "Thank Goodness It's Friday" rehash of the week's events and the prospects for the future. Although about to retire, Kurt provided his very efficient services to the Department in the hectic days preceding and during the Congress.

Kurt and I recall two episodes from the early years. After the annual banquet of the A.O.A. Honor Medical Society, I stopped at the Department in my tuxedo and black tie to find the parking lot jumping with frogs—the result of a plugged drain in the holding tank. I phoned Kurt and we spent the rest of the night in a mammoth frog hunt to ensure that the labs would go on. In 1959, we eliminated some less-than-effective laboratory exercises and decided that the students could use the time for short research projects. They asked if they might meet this requirement on weekends in March so that April would be free to study for finals. From dawn until late at night, the students crowded the laboratory, bringing radios, lunches, and girl friends. Kurt worked indefatiguably and enjoyed every minute, as did the students. There was a sequel—at the Medical Smoker next fall, each of the 60 grateful students wanted to buy Kurt a drink.

In 1952, M. Digby Leigh, Head of Anesthesiology at the Vancouver General Hospital, inaugurated a program whereby his residents, as part of their training, would spend a year as a teaching fellow in physiology and pharmacology (beginning with Jone Chang in 1952–53). Young and medically oriented, they added immeasurably to the laboratory teaching. Also in 1952 my wife and I began the custom of inviting the medical students in groups of 12 to our home for supper (usually beer, kidney bean casserole, and gingerbread). These pleasant gatherings continued until my sabbatical in 1969.

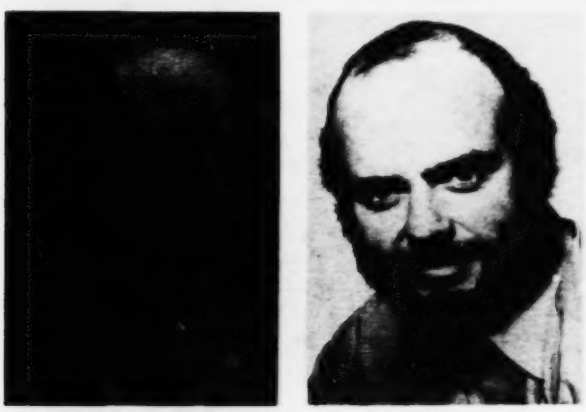
In 1954, I appointed Margaret E. Kennard, who had trained under Fulton, as a part-time Associate Professor to be responsible for the course in neurophysiology—a position she held for the next two years. We also appointed a brilliant young endocrinologist, Jan Wolff (M.D., Harvard; Ph.D., California), as Assistant Professor and Markle Scholar. Unfortunately, he was prevented from leaving the United States by the medical draft and met his military obligations as an officer at the National Institutes of Health. On completing his service, he remained at NIH and is now Chief of the National Institute of Arthritis, Metabolism and Intestinal Diseases. In his place, we appointed Carl F. Cramer, whom I had known as a Ph.D. student at California. He has proven to be a valuable member of the Department with a special interest in students and laboratory teaching. His research on factors affecting calcium and phosphate absorption is recognized internationally.

On December 21, 1954, Dean Weaver resigned for health reasons. After a prolonged search, during which Rocke Robertson (later principal of McGill) served as acting dean, John W. Patterson was appointed Dean of Medicine in 1956. Coming from Western Reserve, where he had been Associate Dean for Education, he brought with him unbounded enthusiasm for the exciting new program of integrated instruction that had been developed there. His department heads at UBC were less than enthusiastic, particularly after a visit to West-

ern Reserve convinced us that such a program would be impossible to implement effectively with our very limited resources.

It was an important time for the Department. On September 1, 1957, Hugh McLennan became the fourth member of our faculty. With a Ph.D. in biochemistry from McGill, he had trained at University College, London, and the Montreal Neurological Institute before joining the Physiology Department at Dalhousie University in 1955. His distinguished scientific career has been devoted to a study of the role of acidic amino acids in synaptic transmission in the mammalian central nervous system. His numerous publications include a monograph on "Synaptic Transmission" (5). He served on the Council of the Medical Research Council of Canada from 1971 to 1977 (member of the executive 1971–75), and in the Canadian Physiological Society, he was Secretary (1965–69) and President (1972–73). He was Chairman of the Programme Committee of the XXX Congress of the International Union of Physiological Sciences.

In 1958, funds were committed for construction of permanent buildings for the basic medical sciences on campus. For a long time, the faculty had discussed plans for distinctive individual departmental buildings similar to the Karolinska Institute in Stockholm. Dean Patterson insisted on a high-rise tower in which all space would be allocated by the dean's office. At this critical time, I was on six-months leave of absence to serve as a scientific secretary for the second U.N. International Conference on Peaceful Uses of Atomic Energy. On August 28, 1958, Dean Patterson resigned to become Dean of Medicine at Vanderbilt. Shortly after his departure, the faculty council reviewed the plans for the high-rise building and, after considerable discussion, decided to go back to the original proposal. When I returned in September, I was asked to chair the building committee, which was still deadlocked on the question of departmental space allocation. The first committee meeting was short. I pointed out the two alternatives: to decide on the space allocation without due haste (but within the next week) or to continue arguing and postpone the building indefinitely. We opted for the first, and agreed on a 5-4-4-3-3 allocation for Anatomy, Biochemistry, Physiology, Pharmacology, and Pathology, respectively. The building was completed and opened October 27, 1961. Physiology occupied 15,800 square feet at the east end of Medical Sciences Block A (subsequently renamed the D. Harold Copp Building), while Biochemistry occupied similar space at the west end. It has proven to be a happy association, typified by the joint Biochemistry-Physiology Christmas party in 1985. Ironically, after 11 years in a very inflammable hut, the day we moved in, someone had set fire to a pile of building trash adjacent to the air intake and the fire department had to evacuate the smoke-filled building.



Left: Hugh McLennan; *right:* John C. Brown.

Middle Years: 1962–1973

With a permanent building at last, the next 12 years were a period of growth and maturation, with the addition of 8 new full-time faculty and a growth in the research budget from less than $25,000 in 1961 to over $300,000 in 1973. We also had the assistance of two members of the Cancer Research Center, Robert L. Noble (Ph.D., Western Ontario) and John W. Jull (Ph.D., Leeds), who were given faculty appointments in the Department (without pay) to teach endocrinology. In 1963, I made the key appointment of Mary Hashimoto (now Mary Forsyth) as departmental secretary—a position she still holds. The graduate program became active, and the Department graduated nine M.Sc. and six Ph.D. students during this period. An important factor was the development of a Faculty of Dentistry, approved under the presidency of John B. Macdonald, D.D.S., in 1962. An important and perhaps unique decision was to train dental and medical students together in the same courses in the basic medical sciences. The Department of Physiology was considered an integral part of the Dental Faculty and for a time received part of its budget from this source. Funds also became available for new faculty and for construction of an addition to block A (5,800 square feet), which was opened March 20, 1968. This provided space for three new faculty members and flexible student laboratories that could be quickly converted into demonstration theaters or seminar rooms. They were also adapted to the new electronic recording equipment that had replaced the smoked-drum kymographs.

These were also exciting years for my own research on calcitonin (2). The controversy with regard to the gland of origin and the alternative name, thyrocalcitonin, was resolved when we demonstrated that the hormone was present in the ultimobranchial glands of lower vertebrates (1966). The next year, we isolated salmon calcitonin from 100 kg of glands. Because of its stability and high potency, it is now used widely (in its synthetic form) for the treatment of Paget's disease of bone and severe postmenopausal osteoporosis.

In 1965, I made a key appointment when I persuaded a somewhat reluctant John C. Brown to join the Department. He received his Ph.D. from the University of Newcastle in 1964 and was at the time a visiting scientist in the laboratory of Donal Magee at the University of Washington. There he had developed the surgical skills for preparing various gastric and intestinal pouches. Using these techniques, he demonstrated an inhibitor of gastric secretion in crude preparations of CCK-PZ, which was absent from highly purified preparations. He subsequently isolated and determined the amino acid structure of this substance, which he called

gastric inhibitory polypeptide (GIP). It has subsequently been shown by Dr. Brown and his associates to be an important part of the entero-insular axis, facilitating glucose-stimulated insulin secretion. High levels of GIP may be a factor in high insulin obesity. He has also isolated a second intestinal hormone, motilin, that modulates motor activity in the gastrointestinal tract. He is the author of *Gastric Inhibitory Polypeptide* (1). For his outstanding research achievements, he was elected a Fellow of the Royal Society of Canada in 1980; he received the Ernst Oppenheimer Award of the Endocrine Society in 1979, the McLaughlin Medal in Medical Science of the Royal Society of Canada in 1982, and the Gold Medal of the Science Council of British Columbia in 1983. He also organized the VI International Congress on Gastrointestinal Hormones held in Vancouver July 6–10, 1986.

The next year, C. Owen Parkes (Ph.D., Alberta, 1965) joined the Department after being brought to Vancouver to assist me in the isolation of calcitonin. He subsequently expanded his field of interest to a study of vitamin D–dependent calcium binding proteins. In the same year, Ralph Keeler (Ph.D., Birmingham, 1956) was appointed Assistant Professor. He had served as Lecturer in Physiology at University College, Ibadan, Nigeria, from 1956 to 1959 and then as Lecturer in Physiology at the University of Newcastle from 1959 to 1966. His research has focused on the renal control of extracellular volume and composition, particularly with regard to factors that increase sodium excretion (including the recently discovered atrial natriuretic factor).

John R. Ledsome

The year 1968 marked the completion of the dental addition and the very important appointment of John R. Ledsome to the faculty at the rank of Associate Professor. He received from the University of Edinburgh the M.B., Ch.B. in 1955, and the M.D. (with honors) in 1962. He spent three years in Malta as Medical Officer to the First Submarine Squadron, returning to Leeds as Lecturer in Physiology from 1959 to 1968, with the exception of a year (1964–65) spent in postdoctoral research in Dr. Comroe's Cardiovascular Research Institute in San Francisco. He has been concerned with control of the cardiovascular system and in particular the function of low pressure receptors. He has chaired a number of committees of the Medical Research Council of Canada and of other bodies. He was appointed to succeed me as head of the department when I retired in 1980; this appointment was renewed for a second five-year term in 1985. In the Canadian Physiological Society, he served as secretary from 1972 to 1975 and as president in 1980–81. In the latter capacity, he was largely responsible for bringing the XXX Congress of the International Union of Physiological Sciences to Vancouver July 13–19, 1986, and was chairman of the Organizing Committee for the Congress.

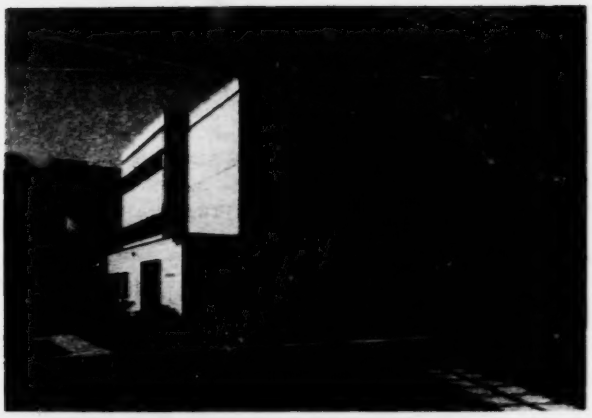
We arranged with the newly appointed Dean of Pharmaceutical Sciences (B. E. Riedel) to offer a third-year course in human physiology (Physiology 301, 302) for his students in 1968. The course, which provides a basis for our Honours program, is open to qualified students from all faculties, with a current enrollment over 400. The next year I made three important appointments: Harry Kohne, who still heads the departmental instrument shop and services our equipment; Franco Lioy, who had graduated in medicine from the University of Rome with high honors and completed his Ph.D. under Maurice Visscher at Minnesota; and J. Anthony Pearson (Ph.D., Newcastle) from the Physiology Department at Newcastle. Dr. Lioy's research is focused on chemoreceptors and the nervous control of the cardiovascular system, while Dr. Pearson is studying the modulation of nociceptive neurons. In 1970–71, I took a sabbatical in London, England, leaving the Department in the charge of Dr. Ledsome and Dr. McLennan.

In 1971, we appointed Peter Vaughan (Ph.D., Monash), a good cobber from Down Under who found the Department fair dinkum. In addition to coordinating the Honours Programme, his research has dealt with myophysiology and particularly the mechanisms of ion permeation in skeletal muscle. The next year, Nadine Wilson (Ph.D., UBC) joined the faculty. She had worked for me as a technician from 1956 to 1958 and was later involved in research in the Obstetrics Department at the University of Southern California. An excellent teacher, she has responsibility for the endocrine courses and has research interests in neurophysial hormones. This was the year that David Bates (M.D., Cambridge) was appointed Dean of Medicine at UBC. An expert in respiratory physiology and problems of air pollution, he had been Chairman of the Physiology Department at McGill. It was logical that he be appointed Professor in the Department here, where he made a very significant contribution to the teaching of respiratory physiology.

To the Present: 1974–1985

The last 12 years have seen further growth and development, with appointment of 8 new faculty members: 4 on university budget (Mathers, McIntosh, Miller, and Pederson), 2 Medical Research Council Scholars (Kasting and Leung), and 2 BC Health Care Scholars (Baimbridge and Buchan). During this period, the Department graduated 13 M.Sc.'s and 26 Ph.D.'s. For the past 6 years, we have had the largest honors program in the university, graduating 6–18 students a year. Many go on to medicine and dentistry, but some enter the graduate program here or elsewhere with an eye to a career in physiology.

From 1977 to 1979, I also served as Coordinator of Health Sciences and was involved in the negotiations that made $50 million in Health Resources funds available to build a university hospital and improve the facilities for the Health Schools. This included funds for expansion of facilities for our Department. Unfortunately, a simple addition to the building would have required upgrading the original Block A to meet the new building standards, at a cost exceeding the funds available. The solution (suggested by our architect, Fred Brodie) was to build a new and independent structure located a few mm away from and connected to the



View of "independent structure" added to Physiology wing of D.H. Copp Building in 1980.

existing building. The increased space (13,000 square feet) included research laboratories and an enlarged shop in the basement; a library/seminar room, departmental offices, and honors laboratory on the first floor; expanded facilities for neurosciences on the second floor; and space for Dr. Brown's endocrine group on the third floor.

In 1972, James J. Miller and Raymond Pederson were appointed to the faculty. Both had done doctoral or postdoctoral work in the Department. Dr. Miller (Ph.D., Western Ontario) is concerned with potentiation in the hippocampus, generation and spread of epileptiform activity in the central nervous system, and calcium regulation in brain cells. Dr. Pederson (Ph.D., UBC), who trained with Dr. Brown, is studying the entero-insular axis. In 1979, Christopher H.S. McIntosh (Ph.D., London) was appointed to staff. He has continued his association with Dr. Brown in the isolation and characterization of gastrointestinal peptides.

I retired as head of the Department in 1980; Dr. Ledsome was appointed my successor. It was a happy choice, and under his direction the Department has gained four new faculty members, an enhanced honors and graduate program, and the invitation to host the XXX Congress of the International Union of Physiological Sciences. In 1982, he appointed David A. Mathers (Ph.D., Nottingham), whose research is concerned with studying the ionic channels induced by neurotransmitters and by hormones in the membranes of nerve and muscle cells. A year later, Norman W. Kasting joined the Department as a Medical Research Council Scholar with an interest in the interaction with brain of the neuropeptides vasopressin and oxytocin and their potential role in thermoregulation. In 1983, two BC Health Care Scholars were appointed: Kenneth G. Baimbridge (Ph.D., Southampton), with an interest in the calcium-binding proteins of the brain, and Alison M. J. Buchan (Ph.D., London), who is working on the immunocytochemical localization of peptide hormones in gut and other tissues. In the same year, Peter C. K. Leung (Ph.D., Western Ontario) was appointed Medical Research Council Scholar in Obstetrics and Physiology, with a research interest in reproductive endocrinology.

Retrospect

It is with certain pride and satisfaction that I look back on the past 35 years from the beginnings of the Department in 6,000 square feet of shared space in hut B-6, an operating budget under $20,000, and 2 faculty members, to its present status in a permanent building with 37,000 square feet, a budget of $2,761,398 (university: $1,007,920; research: $1,753,478), and 17 faculty members. It has been a distinguished group, including six Fellows of the Royal Society of Canada (Bates, Black, Brown, Copp, McLennan, and Noble) and a Fellow of the Royal Society of London (Copp). It has also been remarkably stable, for only one member of the full-time professional staff has left voluntarily over that period (Dr. Parkes resigned in 1984 to move to France). This is apparent in the strong esprit de corps among faculty, staff, and students, in evidence at departmental parties and sporting events, including the annual Conkers Championship at which contestants attempt to smash their opponents' horse chestnuts dangling from a string. However, the greatest evidence for this spirit came when the department hosted the XXX Congress of the International Union of Physiological Sciences July 13–19, 1986, and welcomed physiologists from all over the world.

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History of Physiology Department at University of Florida: 1956–1981

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The University of Florida College of Medicine opened the doors of its not-yet-completed Medical Sciences Building to the first entering class of students in September 1956, and instruction in anatomy and biochemistry began. A month later the section of the building allotted to physiology was ready for occupancy, and the three original members of the Department of Physiology took possession of their laboratories and offices.

The medical school had been officially "created" by the Florida State Legislature in 1949, after preliminary surveys dating back to 1945, but until late 1955 none of us was aware of its development. Indeed, we did not know that a place called Gainesville, Florida existed.

I had first learned that a new medical school was being built at Gainesville from Thomas H. Maren, who, on one November day in 1955, dropped into my office in the Department of Surgery at The Johns Hopkins University School of Medicine. He informed me that a new medical school was developing at the University of Florida in Gainesville, that he was head of the Pharmacology Department, that heads of Anatomy, Biochemistry, and Pathology had also been appointed, but that candidates for Physiology were still being recruited. He made it all sound very exciting, and I said that although I was quite happy where I was, I would be interested in exploring the possibilities at Florida.

A few days later I received a letter from Dean George T. Harrell, inviting me to become a candidate and to come to Gainesville for an interview. I made the trip early in January, and after spending a day and a half I committed myself as a candidate. I had no further communication with Florida until March 28, 1956, when George Harrell phoned to offer me the position as Head of Physiology. I asked for a few days to think about it.

I sought advice from my superiors. Alfred Blalock, a native Southerner, assured me that Florida would be a fine place to live. Philip Bard admonished me to make sure that I would not "have to run to some damned dean" every time I wanted to spend a nickel. After spending a week of consideration, discussion, and decision, I accepted. Thus the Physiology Department at the University of Florida began.

The projected first-year budget for the department had lines for one associate professor and one assistant professor, so my first problem was to fill these positions. I made the decision to try to find individuals with research interests different from my own to provide a broader base of teaching. Within a few weeks two people, both of whom I had previously known at the University of Rochester, were chosen. Melvin Fregly, Instructor at Harvard, was selected to be the Assistant Professor, and Ernest Wright, Assistant Professor at Rochester, was selected to be the Associate Professor. Fregly's special interests were endocrinology and regulatory physiology; Wright's were neurophysiology and electrophysiology.

This faculty recruitment was accomplished in the spring while I was still at Johns Hopkins. I moved to Florida on July 5 and was followed by Fregly and Wright a few weeks later. My summer was spent in temporary quarters, designated Building A, drawing up specifications for laboratory furniture, ordering apparatus and supplies to equip the teaching laboratory for the course we were scheduled to offer the medical students beginning in January 1957, and generally planning for the future. A fairly generous equipment budget of $50,000 had been allowed, and an additional $10,000 had been provided to equip a shop.

In October we moved into our offices and laboratories on the fifth floor of the New Medical Science Building. Here we had been assigned 6,500 square feet of space, not counting lecture rooms or the 2,400-square-foot teaching laboratory that was to be shared with Pharmacology. We enjoyed an exciting but somewhat hectic autumn. The course we were to teach the next semester had to be outlined in detail and a laboratory manual put together. A program had to be developed for our two graduate students, Stephen Cain, whom I had brought from Johns Hopkins, and John Reuben, who had come from Rochester with Ernie Wright. Another problem was making arrangements for procuring dogs and cats needed for the teaching laboratory and for research.

The previously ordered equipment and supplies began to arrive as did some research apparatus that we had been permitted to move from our previous locations. The major shop equipment had not yet been delivered, but our laboratory mechanic George Rosenworth displayed his initiative and ingenuity by using available hand tools to fabricate dog boards out of lumber salvaged from packing crates. Some of these are still in use today.

The opening session for our physiology course was on January 28, 1957, with a class of 3? medical students. The course occupied 15 hours per week for 16 weeks. The typical weekly schedule included 4 hours of lecture, 10 hours of laboratory, and 2 hours of conference. The bulk of the lectures was divided about evenly among our three faculty. None of us had much experience in renal physiology, and we enthusiastically welcomed the offer of Dr. Maren and his guest, the eminent renal physiologist E. K. Marshall, to contribute their expertise to this section of the course. Dr. Marshall approached the subject from a historical and personal point of view, and his crisp, scholarly lectures were both instructive and entertaining. We were fortunate to have him avail-

1, Arthur Otis (1961). *2*, Melvin Fregly (1970). *3*, Ernest Wright (1964).

able for the course in several subsequent years, during which his lectures were taped and later published (*The Physiologist* 9: 367–384, 1966).

We attached much importance to the laboratory part of the course. Our laboratory manual was largely plagarized from those with which we were already familiar, and we could boast that the laboratory exercises must be superior, because they had been selected off the top from Rochester, Harvard, and Johns Hopkins. Each laboratory exercise was a somewhat hectic experience. We were often uncertain whether all the equipment and supplies would actually be available. Sometimes essential items would arrive at the last minute; sometimes we had to improvise. For this, the shop was an invaluable asset.

Although teaching and organizational problems occupied a large part of our time during the first year, we managed to get our research laboratories equipped, organized, functioning, and supported by outside funds totaling $66,335. Indeed, Melvin Fregly, who began some experiments almost immediately after moving into his laboratory, was able by May to submit the first paper based on research done in the department, which appeared in the December 1957 issue of the *American Journal of Physiology* (Fregly, M. J. Adrenal glands in the development of renal hypertension. *Am. J. Physiol.* 191: 542–548, 1957).

In summary, during its first year of existence the department had organized and presented a course in physiology for medical students, had established a graduate program, and had initiated and obtained outside support for research programs, of which one had actually produced publishable results.

I next present categorically some developments over subsequent years.

Faculty

Early in the second year (1957–58) two additions were made to our faculty: Wendell Stainsby, who took over the teaching of cardiovascular and muscle physiology, and Sidney Cassin, who assumed responsibility for renal physiology. Along with Fregly and me they form a quadrumvirate that gave continuity and stability to the department during its first 25 years. It would be a decade before additional permanent faculty were added.

Ernest Wright retired for personal reasons in 1970. He had already diminished his commitment to the department several years earlier, and the teaching of neurophysiology had been largely taken over by Robert King, who had moved into Physiology from the Department of Surgery, and John Munson, who had been recruited by Wright as a research associate. In 1971 both King and Munson were transferred into the Neuroscience Department that was being initiated under the direction of Fred King, but for several years they retained joint appointments in Physiology.

In 1967 William Dawson, whose primary appointment was in Ophthalmology, was given a salaried joint appointment in Physiology. Over the next decade three more lasting appointments were made: in 1970, Marc Jaeger (respiratory physiology); in 1972, Philip Posner (cardiac electrophysiology); and in 1975, George Gerencser (epithelial transport and gastrointestinal physiology). All of them, along with Stainsby, Cassin, and me, are now full professors and tenured members of the faculty. In 1979 Fregly was advanced to the special rank of Graduate Research Professor.

Three individuals held faculty rank for shorter periods: Edward Otey (1962–64), Daniel Belkin (1965–71), and Martin Fisher (1974–81). There were also two interium appointees: Norman Joels for the year 1963–64 and Gordon Ultsch for 6 months in 1972.

All of these faculty were hired without the appointment of an official search committee and without formal advertising followed by a waiting period.

Several individuals with primary appointments in other departments have held joint appointments in Physiology without stipend for various periods. These so-called courtesy appointments have not been perfunctory but have been linked to some function or contribution, such as teaching, graduate student supervision, or research collaboration. We are proud to have on our list of joint appointees such names as Lester Dragstedt, the distinguished surgeon and gastrointestinal physiologist; Robert Pitts, well-known for his fundamental work in renal physiology and author of *Physiology of the Kidney and Body Fluids*; and Donald Barron, a pioneer in perinatal physiology and an ardent student of historical aspects of physiology. The opportunity to associate with men of this stature enriched our department greatly.

Anthony Manning Perks is in a rather special category. Tony was our first Postdoctoral Fellow (1959–1961). He is now Professor of Zoology at the University of British Columbia but for many years has returned to Florida annually for several weeks with the title of Adjunct Research Scholar to do collaborative research with Sidney Cassin. In 1980–81 he spent a full sabbatical year with us.

In 1979 I retired as Chairman but served for an additional year as Acting Chairman.[1] In 1980 the de-

[1] I was originally appointed as head but ended as chairman. Apparently someone in the university hierarchy had once decreed that committees had chairmen, but departments had heads. Sometime later, however, "chairman" became the in word and "head" was out.

partment was given new leadership and direction with the appointment of a new Chairman, M. Ian Phillips, and thus a new chapter in the history of the department began.

Teaching

During the early years we regarded the teaching of medical students to be our primary obligation as a department. The first order of priority for secretarial time was for materials related to teaching.

Each year we had many departmental meetings to plan the course and consider ways of improving it. During the teaching period we met weekly to instruct each other, so that we would be properly prepared for participation in laboratories and conferences that dealt with topics other than those in which we claimed special expertise.

Few major changes were made in the course plan or schedule during the first six years, but minor adjustments were made each year in the arrangement of lectures and conferences. The latter were sometimes held on Saturday mornings, a practice rarely encountered today. By 1959 the class size had increased to 48 medical students. This was the planned capacity of the teaching laboratory, but we found room to accommodate a few graduate students.

We continued to regard the laboratory as the most important medium for teaching. Each student was required to own personally a stethoscope, a sphygmomanometer with blood pressure cuff, and a dissecting kit including a scalpel, large and fine scissors, large and mosquito hemostats. The students themselves were subjects in some experiments. Many experiments involved animals; in a typical year (e.g., 1959) we used 48 turtles, 168 jumbo frogs, 12 bullfrogs, 48 dogs, 4 rabbits, 24 cats, and 102 rats.

Each student was expected to keep a laboratory notebook, and initially submission of laboratory reports was required for each student. This requirement gradually became less rigorous and eventually disappeared, although it was expected that each student would be able to provide laboratory data for discussion purposes in the conferences.

In 1958 Edward Woodward, Professor and Head of the Department of Surgery, gave the lectures on gastrointestinal physiology. He also ran a laboratory exercise in which fasting, "volunteer" student subjects swallowed stomach tubes or balloons. The latter were actually condoms tied more or less securely to lengths of polyethylene tubing. Occasionally one would fail to reappear when the tube was withdrawn, much to the consternation of the subject and to the amusement of the observers. Some subjects received 400 ml of black coffee or 50 ml of 7% ethyl alcohol via stomach tube; others were given subcutaneous injections of either 20 U of insulin or 50 mg of histalog. The Department of Surgery continued to be responsible for teaching gastrointestinal physiology through the next decade. Beginning in 1960 most of the lectures were given by Dr. Lester Dragstedt, who after his retirement at Chicago had come to Florida to join his former student Woodward.

We also had contributions to our teaching from other clinical departments. Beginning in 1964 Melvin Rubin (Ophthalmology) and George Singleton (Otorhinolaryngology) taught the physiology of vision and hearing, respectively.

The university changed from a semester to a trimester calendar in 1963. This required no change in our course content, but it did involve a rearrangement of our schedule, so that lectures were concentrated in the winter trimester and laboratories in the spring.

In 1968 the university again changed its calendar, this time to a quarter system. This was also an occasion for the first radical revision of the physiology course. After a few introductory lectures in general physiology the class was split into two parts, one of which received instruction in respiration-circulation, the other in endocrinology–body fluids. After a month a rotation was made. This was followed by a week in which the whole class received lectures on selected topics and culminated with a final examination. Neurophysiology was absent from this physiology course. Instead a course in neuroscience was given concurrently by faculty from both Physiology and Anatomical Sciences.

In 1970 we were caught up in the nationwide fad and went to a "fully integrated" curriculum. The separate basic science disciplines disappeared as far as course names were concerned and were replaced by "human systems I and II." Teaching was no longer a departmental functional but was in the charge of various committees, each responsible for an organ system. The Department of Anatomical Sciences was dissolved, and a Department of Neuroscience was created in 1971.

Another development in this period was the opening of the College of Dentistry in 1972. This meant that in addition to 85 medical students, about an equal number of dental students were now enrolled in the human systems courses. Because some graduate students were also registered, the total enrollment now approached 200.

Teaching by committee allowed us as individuals to become better acquainted with members of other departments with whom we might otherwise not have made close contact. For instance, the committee on respiration included members of 11 different departments. Although teaching by committee may have broadened our individual horizons, it gave us less sense of purpose as a department.

Committee teaching as practiced at our institution had a fundamental weakness that contributed to its eventual demise: a lack of any clear lines of responsibility. Faculty participation was essentially on a voluntary elective basis, and as the excitement of the novelty wore off it became increasingly difficult to obtain enthusiastic involvement.

Eventually, in 1976, physiology reemerged as a separate course for which the Physiology Department was responsible. The character of the course was much changed, however. Whereas in the earlier period our course had about 60 hours of lecture and as much as 200 hours of laboratory and conference, it now had as many as 135 hours of lectures, some of which were over one hour in length. Laboratory time was much reduced. By 1979 it consisted only of six three-hour workshops, most of which dealt with respiratory physiology and acid-base balance. Less emphasis was placed on teaching physiology as an enjoyable intellectual challenge and more as a collection of handouts or packages

designed to eliminate active thought or wonderment. Gaining favorable (but anonymous) ratings from students became increasingly important. On the other hand, the sort of personal contact with students that we enjoyed in the days when laboratory teaching had a high priority was almost completely lacking.

On the premise that physiology might be more meaningful to medical students after they had been exposed to clinical studies, we decided to offer in the spring of 1974 a course in pathophysiology as an elective for third- and fourth-year students. Three students enrolled, and the course was run as an informal seminar with the object of encouraging and assisting the students to become independent scholars rather than passive recipients of information. The students met weekly for two 1.5-hour periods, one session with a faculty member, the other with the students alone. The objective was not so much didactically to review physiology as a whole as to explore selected topics in some depth. This course was so well received by the participants that we were encouraged to offer a more formally structured course consisting mainly of lectures given not only by members of the Physiology Department but also by clinical department members with expertise in the physiology of some organ system. Although originally an elective, it has now become a required course. Both its format and degree of enthusiastic acceptance has varied over the years. It seems widely agreed that such a course is desirable; there are varied opinions as to its objectives and format.

No provision was made initially for the department to give instruction in physiology to other than medical students, although we did as a matter of course provide for our own graduate students. With the development and growth of the College of Health Related Professions and of the College of Nursing, we began to receive requests for the teaching of their students. Most of us felt that this was an appropriate function for the department; in fact some of us envisioned the eventual possibility of a university-wide course in human physiology. One member was opposed in principle, feeling that medical and graduate education was our sole mission and that the education of undergradutes should be left to others. All of us agreed that we should not take on any further teaching obligations without additional faculty. Such support was not forthcoming, but finally in 1967 we agreed to teach a course in human physiology for a class of physical therapy students in exchange for funds to support a graduate assistant. This arrangement continued through 1969, with Dr. Stainsby teaching about 40 students during each fall quarter.

Demand for the wider availability of this course or a similar one continued to increase not only within the Health Center but also from other segments of the university. A succession of committees composed of representatives of the concerned colleges and departments were appointed to study the matter, but nothing of substance happened because no one was both willing and able to provide the support we required.

In 1971 we agreed to admit students of nursing and of other Health Center colleges into our course. In return, the Health Center Provost, Edward Ackell, (to get the Dean of Nursing off his back, he said) provided us with a postdoctoral position to be followed in 1972 with a regular staff position. This resulted in the addition of Philip Posner to our faculty.

This course has continued to be available to Health Center students. Some years it was taught in each of the four quarters to a total of more than 200 students. With only one exception, every member of the department has, on occasion, taken responsibility for this teaching, although Stainsby has devoted the most time to it. Graduate students and postdoctoral fellows have also participated, and with the virtual elimination of laboratory exercises in the medical student course, this became the only teaching experience they received during their training.

In addition to this course we have occasionally offered on a one-time basis courses for special groups such as physician's assistants, engineers, and anthropologists. However, our dream of a university-wide course in human physiology for undergraduates never came to fruition.

Research

Although we accepted teaching as the primary mission of the department, that is not to say that we considered research a less important activity. We regarded research more as a personal privilege than as a departmental duty, and we were grateful for the generous amount of time and for the excellent facilities available to us. In this approach we may have been influenced by the example of Wallace Fenn, who was once quoted as saying that research, in his department, "has been organized as little as possible and depends entirely on the interests of the individual members of the staff" (2).

This individual rather than departmental control of research activities is reflected in the diversity of fields of investigation. These included perinatal physiology (Cassin, Perks), vision (Dawson), endocrinological and nutritional aspects of hypertension, behavioral aspects of body fluid balance (Fregly), transport mechanisms in epithelial cells (Gerencser), respiratory mechanics (Jaeger, Otis, Fisher), respiratory gas exchange (Otis), cardiac electrophysiology (Posner), mammalian skeletal muscle (Stainsby), and various aspects of comparative physiology (Belkin, Dawson, Perks).

Individualism does not mean isolation. Ideas, expertise, and equipment were often shared. Collaborative research occurred both within the department and with members of other departments and occasionally with members of other institutions. Such joint activities were always spontaneous, never forced.

A weekly physiology seminar was established early in the first year; its regular meeting time still remains Monday, 4:00 p.m. A diversity of speakers has enhanced our awareness, not only of research within the department but also of that going on in other departments of our university and in the laboratories of other institutions both here and abroad. Computers have not abolished the need for verbal communication.

During the period covered by this history our research was well supported by funds from such sources as National Institutes of Health, National Science Foundation, U.S. Air Force, U.S. Navy, American Heart Association, and National Aeronautics and Space Administration. We felt little pressure to obtain outside

4, Wendell Stainsby (1970). *5*, Sidney Cassin (1970). *6*, Edward Otey (1964). *7*, Norman Joels (1964). *8*, Robert King (1970). *9*, Daniel Belkin (1970). *10*, John Munson (1970). *11*, William Dawson (1970). *12*, Marc Jaeger (1980). *13*, Philip Posner (1972). *14*, Martin Fisher (1980). *15*. George Gerencser (1978).

support, partly because it was relatively easy to do so and partly because our salaries did not depend on it.

Our continuous, steadily increasing productivity during the period 1956–80 is documented by 381 publications in journals or books. In addition we have been well represented at meetings and symposia, especially those of the American Physiological Society. I believe that there has not been a meeting of the APS during this period at which the department failed to be represented. Indeed, at most meetings several papers have been presented. We also have been represented at all International Physiological Congresses.

Graduate Program

We brought with us two graduate students who had already started their training with us. This was rather presumptuous on our part, because we did not have a graduate program. Moreover, we knew nothing about the procedures required to establish one. It immediately became clear that our students could not enroll for graduate work in physiology, because we didn't exist as far as the Graduate School was concerned. This technicality was taken care of temporarily through the kindness and understanding of Professor H. K. Wallace, Head of Zoology, who allowed our students to register nominally in his department, even though they took no courses there.

In addition to Physiology, the Departments of Anatomy, Biochemistry, and Microbiology also either already had or hoped soon to recruit graduate students. We all soon discovered that for a department to offer graduate work leading to a Ph.D. degree it was necessary to submit a formal petition to the Graduate Council of the University of Florida, presenting the need for such a degree, a description of our facilities, the qualifications of our faculty, a statement of the requirements for earning the degree, and a list of the graduate level courses to be offerred.

Discussions were held with Graduate School Dean Linton E. Grinter, who appeared to be favorably impressed with our individual credentials but regarded the notion that a department consisting of only three individuals could mount a graduate program as being naive and somewhat ludicrous.

The departments concerned satisfied Grinter's reservations by joining forces. In our petition, which occu-

pied 101 typewritten pages, we "proposed that a single degree, Doctor of Philosophy in Medical Sciences, be awarded with the scientific discipline of major concentration indicated by name."

President J. Wayne Reitz appointed a "Committee of Inspection," consisting of five faculty members from various departments within the university and two outside consultants, to study the petition, interview us, and make recommendations. After this group had carried out its duties and deliberations, our proposed program was approved by the Graduate Council in May 1957 and was put in operation beginning with the 1957–58 academic year.

Our first Ph.D. degrees were granted in 1959 to Stephen Cain and John Reuben. Through the period covered by this history (1956–80), 26 doctorates and 31 masters degrees have been given.

Our general philosophy of graduate training was based on the development of individual talents rather than forcing all individuals into the same mold. Our requirements were rigorous but not rigid. If the students did not already have a reasonable background in chemistry, physics, and mathematics, as well as in biology, they were expected to remedy such deficiencies. Most students, unless they had previously taken equivalent courses, were advised to take the medical school courses in human physiology, biochemistry, histology, and neuroanatomy. A course in statistics was also recommended. Reading competence of a foreign language was a requirement initially, but this was later dropped, when the Graduate School made its optional. A variety of seminar-type courses have been offered in special areas of physiology representing generally the personal interests of the faculty. Our first courses of this type were nerve-muscle physiology, respiration and circulation, body temperature regulation, and recent advances in physiology. The last was designed to allow the offering of a course on any topic that struck the fancy of a faculty member. Over the years and with the addition of new faculty, the number and variety of these seminar courses has increased.

Satisfactory performance on a qualifying examination consisting of both written and oral parts is required for admission to candidacy for the Ph.D. degree. We have experimented with various formats for these examinations in an attempt to make the students regard them more as pleasant opportunities to demonstrate their knowledge and intellectual prowess than as harassing ordeals. Despite our efforts, most students still find them stressful.

A principal purpose of our graduate program is the development of individual talents, capabilities, and attitudes for independent research. As stated in our petition, "The completion of a satisfactory dissertation is the most important single requirement of the Ph.D. degree."

We did not aspire to a numerically large graduate program but preferred to have a small number of students to whom we could give close personal attention. We were able to provide financial support to nearly all students. State funds were available each year for one or more assistantships; others were provided from research grant funds. During the decade beginning in 1969 we were generously supported by training grants from the National Institutes of Health.

16, Anthony Perks (1980). *17*, Old and the new: Arthur Otis and Ian Phillips (1980).

As viewed from the outside the quality of our graduate program has been reasonably successful. In 1965 the American Council of Education gave us an "adequate plus" rating; in 1970 we were advanced to the "good" category. Of more significance to us is the fact that with a rare exception all those to whom we have awarded the Ph.D. degree are now appropriately employed. Of the 29 receiving this degree, 19 are full-time faculty members in various institutions, 4 are doing research in laboratories supported by the government, industry, or private foundations, 3 are physicians in private practice, and 2 are physicians in training for careers in academic medicine. Of recipients of the Sc.M. degree 5 are known to be physicians, 4 have received a Ph.D., 3 are faculty members in colleges of veterinary medicine, 1 is a junior college faculty member, and 1 is a dental student. Others have responsible positions as research associates or assistants in various laboratories.

Postdoctoral Training

Our initial budget from the state included a line for a postdoctoral fellow. Our first fellow was Dr. Anthony Manning Perks (1959–61). He was attracted by a flyer advertising a fellowship at the University of Florida that appeared on a notice board at St. Andrews University, Scotland, where he was completing work for his Ph.D. degree.

Up to 1981 we have had 30 postdoctoral fellows, trainees, or research associates who have remained in the department for periods varying from a few months to several years. They have come from all regions of the United States and several foreign countries. Some have come with their own financial support; some have been supported by funds from research grants and others by training grants provided by the National Institutes of Health and by the Parker B. Francis Foundation. Beginning in 1976 several minority trainees were supported during the summer months by a Summer Minority Hypertension Research Program funded by the National Institutes of Health with Dr. Fregly as responsible investigator. The amount available from the state budget for a postdoctoral fellow failed to keep pace with inflation after the early years and was diverted to the support of graduate students.

Our postdoctoral fellows, coming as they have from so many different backgrounds, have livened and enriched our department culturally as well as scientifically; we trust that in return we have given them something of lasting value.

Service

Although teaching and research were our primary activities, we were also involved in what are often called service functions. Within the institution this meant membership in some of the many appointed bodies deemed necessary for the governance and operation of the university or college, e.g., the University Senate, the Graduate Council, and Committees for Admissions, Tenure and Promotion, Academic Status, Animal Care, Human Experimentation, and Curriculum. For a five-year period Fregly was Assistant Dean for Graduate Education in the College of Medicine. We also provided two secretaries and two presidents of the local chapter of Sigma Xi.

On a less provincial level we were represented on Study Sections, Scholarship Review Committees, Task Forces, Site Visiting Teams of the National Institutes of Health, on similar bodies of the National Science Foundation, on editorial boards of several journals, and on the National Board of Medical Examiners.

We were interested and active in the affairs of the American Physiological Society. We were represented on editorial boards of *Physiological Reviews, Journal of Applied Physiology, American Journal of Physiology*, and *The Physiologist*. We were appointed to committees of the Society: Care and Use of Animals, Membership, Public Affairs and Public Information, Committee on Committees, Centennial Celebration, Senior Physiologists, Program Executive, and Porter Fellowship. Clearly, we regarded APS as our Society.

Vietnam War Period

The Vietnam War had impacts on the citizens and institutions of our country that are too complex to attempt to describe here. The following anecdotal comments are superficial observations of a deeply rooted turmoil.

During this period the expression of student unrest here was much more benign than that experienced by some institutions. Nonviolent demonstrations were held on the main campus, one with Jane Fonda as the chief attraction. Part of her act was reading titles of research projects that were funded by agencies of the military and briefly decrying each one. She interpreted "Studies of Gas Exchange" (the title of our contract with the School of Aerospace Medicine) as the development of new methods for poison gas warfare. We made no attempt at refutation.

Our medical students during this period were relatively placid, at least as far as external manifestations were concerned; they indulged in no violence and staged no sit-ins. They did make it clear that they wanted to be taught only that which was directly relevant, just the bare-bones essentials. When one student came to me with such a plea, I suggested that he might like to give the lectures for the acid-base segment of the course. He accepted that challenge. With a modicum of guidance he prepared himself, made a credible presentation, and apparently left the class no more confused than those of other years. There were, however, no more volunteer instructors.

Personality of the Department

Every department has its own personality. How can ours be characterized? In 1957 Edward Adolph visited our young department as an emissary of the Education Committee of APS. In his report regarding our department he wrote, "It has almost no rules of operation and thus furnishes a freedom that is not enjoyed by long-established departments." To a large extent this freedom was maintained over the years. There were no written rules, but it was clearly understood that high-pressure gas tanks must always be secured, that radios must not be audible beyond their home rooms, and that when faculty members were displeased with the consequences of having issued unclear instructions or illegible handwriting, they were to vent their emotional outbursts not on a secretary, who might respond with a burst of tears, but on the chairman, who certainly would not.

We began and remained a friendly, informal group readily available to each other and to all students. Doors to laboratories and offices were seldom closed during working hours, unless experiments demanding no interruption were in progress.

Departmental meetings, aside from those related to teaching, were not held on a regularly scheduled basis. A meeting was called whenever circumstances seemed to require it or whenever a faculty member, for any reason, requested it. They were always informal and often spirited affairs. Everyone had a chance to speak his piece. Minutes were seldom kept.

How did the department regard itself in comparison to others? In 1974, the Dean of our College, Chandler Stetson, in connection with a salary study he was making, requested the chairman to furnish a list of physiology departments that we felt to be equal quality-wise to our own. I asked each faculty member to list five departments. Thirty-two different schools were named. Those mentioned more than once were Mississippi (4); Rochester, University of California at Davis, Oregon, and Dartmouth (3 each); Kentucky, Michigan State, Missouri, and State University of New York at Buffalo (2 each). Whether these departments would be pleased or vexed to be regarded as our peers is not known. The question has never been asked.

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History of Department of Physiology at University of South Florida

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The Department of Physiology of the College of Medicine of the University of South Florida is a component of a relatively new university. The University of South Florida was founded in 1956, with the first students entering four years later. It is currently the second largest university in the State of Florida with an enrollment of over 27,000 students. The College of Medicine was authorized in 1965, and the first full-time Dean, Donn L. Smith, M.D., Ph.D., was appointed in 1969.

The Department of Physiology was established February 1, 1971, with the appointment of the first and current chairman, Carleton H. Baker. The charter class of 24 medical students entered in September of that year. Dr. Baker received his Ph.D. degree from Princeton University in 1955. In that same year he was appointed Assistant Professor of Physiology at the Medical College of Georgia, rising to Professor over the next 12 years. During this time, he was associated with W. F. Hamilton, Philip Dow, and John W. Remington and developed his interest in the peripheral circulation. In 1967 he accepted the position of Professor of Physiology and Biophysics at the University of Louisville Health Sciences Center, remaining there until accepting the South Florida appointment.

The Department of Physiology in 1971 consisted of the Chairman's office and a secretary's office on the fourth floor of the Science Center. In the summer two faculty joined the Department, Darrell L. Davis as Associate Professor and Richard P. Menninger as Assistant Professor. Since space for the College of Medicine was quite limited, these faculty were placed in offices borrowed from various colleges of the university. The Department had one small research laboratory (ca. 300 square feet) the walls of which were lined to the ceiling with stacks of teaching equipment; however, some published work was accomplished. A year later the Veterans Administration Hospital with a research building opened about one-half mile away. The departmental research laboratories and offices, with the exception of the Chairman's office, were housed in these excellent facilities. The faculty had now increased to five members with the major emphasis on cardiovascular control. In 1975 the new Medical Center was opened with reasonable facilities for the Department. The faculty increased to seven members with the addition of new areas of physiology expanding the Department's offerings. The Ph.D. program was approved during this year, and the first graduate students were accepted. Also, the first Postdoctoral Fellow was appointed.

During the past 10 years one additional position has been added to the Department making a total of 8 full-time faculty. There are also 2 joint appointments and 1 clinical appointment. The current faculty includes Professors Darrell L. Davis (Cardiovascular Physiology), Roger Shannon (Repiration), and John Lott Brown (Special Senses); Clinical Professor Gordon J. Gilbert (Neurology); Associate Professors Joel M. Price (Vascular Smooth Muscle Mechanics), Bruce G. Lindsey (Neurophysiology), Stanley Nazian (Reproductive Endocrinology), and Papineni S. Rao (Toxic Shock of Pregnancy); and Assistant Professors Frank R. Wilmoth (Microcirculation) and John R. Dietz (Renal).

The Department has continued to develop its programs in teaching, research, and service. Although the Department is still relatively young the faculty have been active with editorial boards, National Institutes of Health review groups, and national committees. All members of the faculty contribute regularly to national and international scientific meetings. Several of the faculty have been invited participants in international symposia.

The University of South Florida Medical Center is currently in a phase of rapid growth of its clinical facilities. As this development proceeds it is expected that the breadth of offerings and involvement by the Department of Physiology in the research and teaching activities of the Center will expand greatly.

History of Physiology at Philadelphia College of Osteopathic Medicine

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The Philadelphia College of Osteopathic Medicine (PCOM) is the largest of the 15 osteopathic teaching institutions and the 9th largest of all medical schools in the country. The present name was adopted after several name changes, but for the sake of clarity PCOM is used here for all time periods.

The rapid growth of PCOM during its first 20 years necessitated 6 relocations to different sites. At each relocation there were also numerous interbuilding moves. Many records were lost or inadvertently discarded in these major and minor moves. Additionally, many of the early faculty kept pertinent college records in their private practice offices and these frequently were lost with change of address or retirement. There remain many lacunae in this account and strict chronology sometimes has been difficult to establish.

Origin and Concepts of Osteopathy

Before describing the college in detail it may be worthwhile to consider the origins and concepts of osteopathy in general.

Andrew Taylor Still, the founder of osteopathic medicine, was born on August 6, 1828, in Jonesville, Virginia and died on November 12, 1917, in Kirksville, Missouri. The son of a Methodist missionary who was also a physician, he was exposed early to frontier conditions that engendered in him his lifelong interest in nature and health and disease. He became interested in medicine and soon came to practice "regular" medicine among his fellow farmers. He learned the Shawnee language and ministered to the Indians in their nearby reservations. From this experience he learned anatomy firsthand. Before the Civil War he had attended briefly the College of Physicians and Surgeons of Kansas City. After discharge from the army (with the rank of Major) he resumed his medical education by preceptorship, a procedure typical of the time. He maintained his strong abolitionist convictions and supported the women's suffrage movement all his life. Still soon became disillusioned with the prevailing practice of treating patients with drugs, which had limited benefits but often strong side reactions, or medicinal whiskeys. He came to believe that bodily structures were reciprocally related to their functions (unaware that he was restating Virchow's dictum expressed a decade earlier that "structure was based on function: to know one you must also know the other"). Still recognized that only by study of the normal structure and function can abnormal processes be understood. (A similar concept about pathologic conditions would soon be taught by William Osler of McGill University in his clinics at Johns Hopkins and Oxford.) Still further believed that the body has an innate capacity for healing itself and that restoration and maintenance of health results from removal and prevention of obstacles to the healing processes. The interdependence of structure and function gave rise to the concept that many aberrations in physiology could be corrected by restoring the relationship between anatomy and physiology. "Nature, if given the least opportunity, always tends to revert to the normal" became an osteopathic dictum.

Still reasoned that all organs receive motor and sensory innervation from the brain and spinal cord; hence a disturbance in one organ could bring about changes in other organs. (This antedated by several decades the concept of feedback loops.) The change would be in the nature of responses to irritation, mechanical pressure, abnormal influences of nerve and blood supply, etc. The skeletomuscle system, by its very size and number of components (bones, muscles, tendons, ligaments, fascia, etc.), offers the most prevalent and most visible examples. The activities carried out by this system are mainly mechanical and hence subject to stresses and strains. Other organ systems are also subject to stresses and strains, but these are not as readily apparent. A change in physiologic activity due to mechanical disorders of the body interferes with the body's biochemical processes at normal (what we would now call steady-state) conditions and requires mechanical therapy. The concept of an optimal anatomic adjustment for each aberration in physiology formed the basis for various manipulative procedures.

A corollary of the above is that the body should be studied as a *total unit*, a cornerstone tenet of the present-day osteopathic physician.

Still's success in treatment received wide attention, but he failed to get various medical schools to incorporate his concepts. Osteopathy thus began as a reform movement against the allopath's belief in the use of drugs. That alone, however, did not define osteopathy: there were other methodologies, such as naturopathy, that rejected drugs. Essential to the definition were manipulative treatment to correct mechanicomusculature disorders and the holistic view.

Many who read or heard about Still's success became converts. Among them was William Smith, M.D., a graduate of the University of Edinburgh College of Medicine. Smith was convinced of the merits of the new kind of treatment and after being trained by Still in osteopathic practice, in November 1882 undertook to teach a four-month course in anatomy. The first class "graduated" in 1883. To fill the growing demands for trained practitioners, however, a more formal procedure was indicated, and in 1894 the American School of Osteopathy was incorporated in Kirksville, Missouri. Included in the articles of the charter was the charge to "improve our present system of surgery, obstetrics and treatment of disease generally and to place the same on

a more rational and scientific basis. . . ." [sic] The school was designated by the charter to be a school of medicine, and osteopathy was considered to be a system of medicine. It was on Still's strong insistence that the degree to be awarded would be D.O. and not M.D. The symbol D.O. at first stood for Diploma of Osteopathy but soon became Doctor of Osteopathy.

By the end of the century many osteopathic teaching centers (variously called institutes, schools, or colleges) were founded. Some with questionable motives and others with insufficient funding soon closed. In 1898 the Associated Colleges of Osteopathy (now the American Association of Osteopathic Colleges) came into existence with the objective of regulating the activities of the diverse colleges that had come into operation and establishing acceptable curriculi, entrance requirements, and standards of education. Osteopathy had spread rapidly and those seriously concerned with this important new system of medicine considered such action as the only means of overcoming legal obstacles.

The demonstrated benefits of osteopathic treatment created demands for more osteopaths and this led to the establishment of new schools. The pioneering spirit and missionary fervor of the dedicated osteopath, however, did not account for all the new colleges. It was a foregone conclusion that the success of the osteopathic movement would be a strong attraction for charlatans to open their own brand of osteopathic and osteopathic-like schools, some even mail-order diploma schools.

A strange situation soon developed. On the one hand, the osteopaths were battling the established medical profession for their very existence and, on the other hand, they were battling the "graduates" of fake colleges. Among the latter were the American College of Mechanotherapy, the College of Neuromuscular Medicine, the Western College of Osteotherapy, and the Institute of Manipulative Therapy. The word osteopathy did not always appear in the name but was used in the advertisements. All had one thing in common: the offer of a beautiful diploma that could be displayed with pride in the waiting room.

The bogus "doctors" from these and similar allopathic "colleges" were, of course, incompetent and a potential danger to the public. The credulity of the populace and the absence of legal restrictions were favorable conditions for quacks and quackery. This was not peculiar to the times. At the present, seventy-five years later, even with laws and licensure, there are an estimated 50,000 medical personnel practicing without credentials, many in municipal, county, and federal hospitals.

Beginning of PCOM

It was at this crucial time that the present Philadelphia College of Osteopathic Medicine was founded by two recent graduates, Mason Wiley Pressly and Oscar John Snyder. Within a few years this college adopted standards that were ahead of the other 12 osteopathic schools founded by the end of the century.

Philadelphia was unique in that it was the center of three rival medical philosophies: allopathy (Temple, Jefferson, University of Pennsylvania, Women's Medical); homeopathy (Hahnemann), and osteopathy. (Hahnemann soon relinquished its homeopathic teachings in all but name.) The Women's Medical College later opened its enrollment to men, becoming the present Medical College of Pennsylvania. In the background to all these was the shadowy "medical" philosophy of naturopathy and the teaching of Christian Science.

Mason Wiley Pressly, D.O., cofounder of Philadelphia College of Osteopathic Medicine and first Professor of Physiology (1899–1905).

Mason Wiley Pressly, born June 24, 1859, in Coddle Creek, North Carolina, was characterized by contemporaries as a "perfect dynamo of thought and energy." Like his father he became a Presbyterian minister after graduating in 1882 from Princeton Theological Seminary and taking postgraduate studies at Harvard, Oxford, and Princeton University. He was additionally a student of physiology and in 1897 at age 39 became Professor of Physiology and Hygiene in the American School of Osteopathy at Kirksville. At the same time he also enrolled as a student. Numerous talks and contacts with Andrew Taylor Still and experience with patients made him an ardent convert to the new system of therapy. He transferred to the recently established Northern Institute of Osteopathy in Minneapolis from which he received his D.O. degree in 1898.

Oscar John Snyder graduated in 1880 from the Winona State Normal School in Winona, Minnesota, at age 17 and taught school in Wisconsin for six years. He then took up the study of science, including medical subjects, and graduated with a B.A. degree in 1892 and an M.S. degree in 1894 from Columbian University, now Columbian College of Washington University, St. Louis. He served for five years as an examiner in the United States Bureau of Pensions where he became acquainted with the new drugless medical system. The efficacy of manipulative therapy in curing his sister impressed him so much that he enrolled at age 31 years as a student in the Northern Institute of Osteopathy from which he graduated in 1899.

At the Northern Institute Pressly and Snyder held discussions about establishing their own osteopathic teaching center. They agreed that the more densely populated eastern states held promise of a large pool of

potential students. Philadelphia was selected by Pressly because of its reputation as a medical and educational center: additionally, earlier he had served as a popular pastor in a Philadelphia Presbyterian Church and had numerous well-wishers.

On receiving his D.O. degree in 1898 Pressly came to Philadelphia and set up a teaching institution. Until May 1899 he carried on by himself, giving demonstrations and lectures. However, because of the antipathy of the local doctors of medicine, Pressly was unable to obtain a charter from the State of Pennsylvania. His way around this obstacle was to have the State of New Jersey in January 1899 issue a certificate of incorporation of the "Philadelphia College and Infirmary of Osteopathy" located in two rooms in the Girard Office Building in Philadelphia. The other student, O. J. Snyder, joined him when he received his D.O. degree that year. Snyder became president and Pressly secretary-treasurer. Although not formally so designated, Pressly served in the capacity of dean of the college and in 1902 presided at commencement exercises for the third class of 16 matriculants.

Snyder took on the teaching of osteopathic symptomatology, jurisprudence, and therapeutics. Pressly had been Professor of Physiology and Hygiene in Still's American School of Osteopathy in Kirksville, and he now assumed this role in Philadelphia and, in addition, gave instruction in dietetics as well as the principles of osteopathy that he had learned from Still.

Night classes in osteopathy were held from 1901 to 1903 but then dropped after graduating four students. Similarly an extension school was opened in Atlantic City, New Jersey, in 1899 but soon abandoned. Both closures were due in part to problems of logistics, such as obtaining equipment for teaching fundamentals and cadavers for dissection.

First Decade

The annual increase in student enrollment at PCOM during the first 10 or 12 years was exponential. Soon it seemed that "they came from near, they came from far." There are several reasons for this unprecedented outburst. Unquestionably some were attracted to osteopathy by the lure of ready money. Many were attracted by the desire to become healers, to relieve pain. To this point there was much publicity engendered by satisfied patients who were well-known figures, locally and nationally. Writers, reporters, and editors were especially enthusiastic about the benefits of osteopathic manipulation to obtain relief from neck pain and headaches presumably acquired from their positions before a typewriter. Included were Mark Twain and the *New York Tribune* columnist Mark Sullivan, as well as the editors of the *Philadelphia Inquirer*, the *North American*, and the *Ladies' Home Journal*. Other public figures who obtained relief from osteopathic treatment were the Mayor of Philadelphia, W. Freeland Kenrick, and the actress, Irene Borodoni.

With the public endorsements by such prominent advocates, PCOM grew rapidly. As Still had experienced when he founded his osteopathic school, the first students to enroll in PCOM were former patients or their near relatives.

An unlikely source of students and instructors were doctors of "regular" medicine (i.e., those with M.D. degrees). Some were M.D.'s who then became D.O.'s. W. B. Keene, M.D., one of the two first graduates from PCOM (1900) was among the first seven members of the faculty, an instructor in diagnoses and pathology. James E. Burt, M.D., graduated from PCOM in 1902 and in 1903 became the first dean. A few graduates of osteopathic schools went on to take an M.D. degree as well and then joined an osteopath college faculty. One of these was David Sand Brown Pennock, D.O. (Kirksville, 1901) who then took an M.D. degree at Hahnemann and spent the rest of his life teaching at PCOM. He organized and taught the first course in neurophysiology: later he became Chief of Surgery and started the residency program.

The first osteopathic colleges were established as private corporations, as were most of the allopathic medical colleges. The majority of the stock was held by the founders and their associates. They were men of altruism and vision but not wealth. Ownership of PCOM was vested in the founders, Pressly and Snyder.

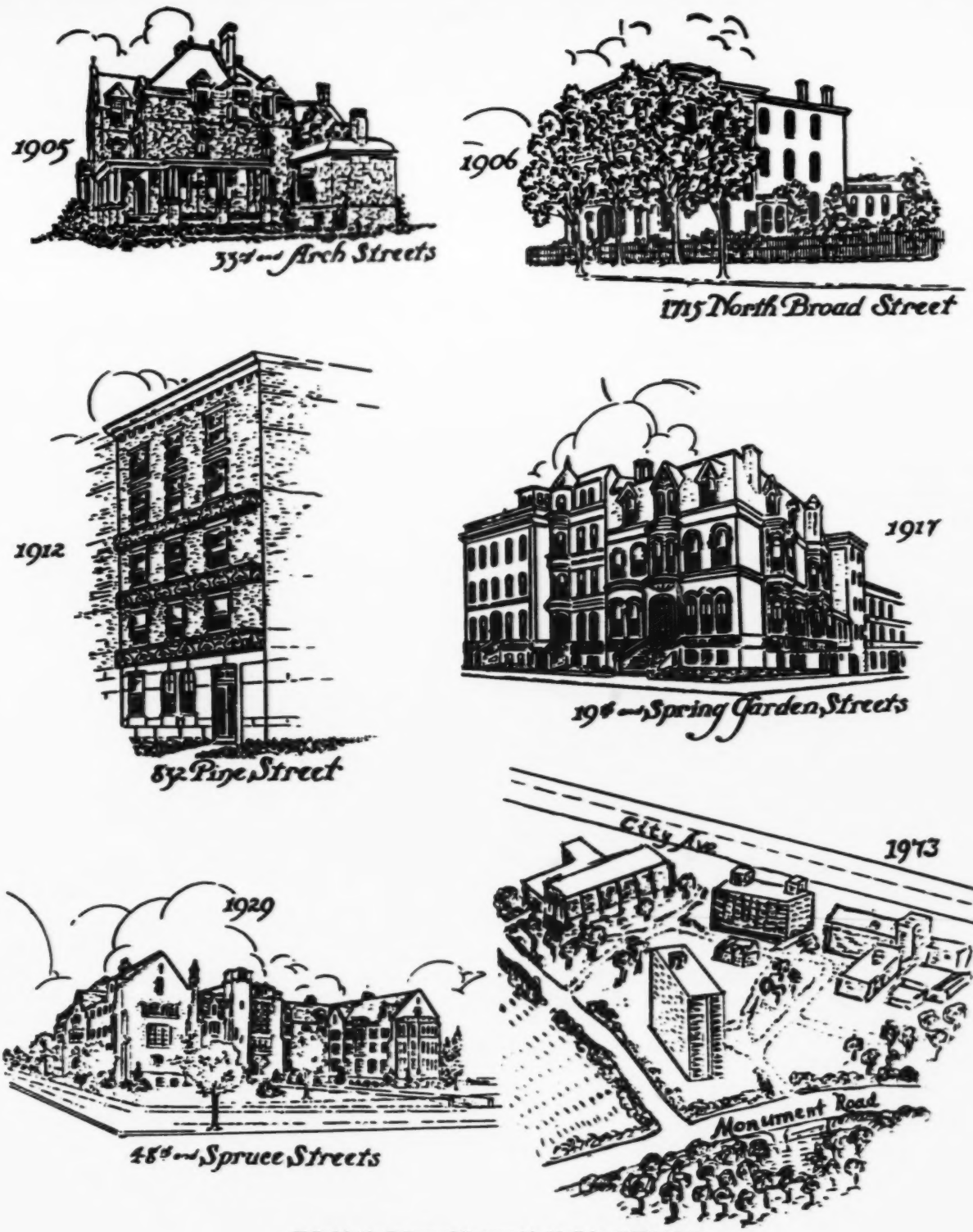
In August 1905, as a result of the disagreement between PCOM faculty and administration about financial remuneration, both Snyder and Pressly turned over their shares to the faculty and severed all teaching connections with the college they had founded. Pressly also resigned as secretary-treasurer and soon left the state. Little is known about his later activities. The *Osteopathic Digest* for June 1930 had a short statement about a visit to Philadelphia, "returning to the scene of an early triumph," but gave no other information.

The death certificate for Mason Wiley Pressly shows that he had been in California for nine years, the last six as a resident in Van Nuys, where he died on February 2, 1942, aged 82 years.

The confusion attending Pressly's leaving probably accounts for the laconic 1905 report on student grades for physiology. "All passed—grades lost." Four additions to the staff (two with D.O. and two with M.D. degrees) had recently been made for teaching fundamentals, and one of these filled the instruction void in physiology created by Pressly's departure.

Although he too had relinquished his instructional duties, Snyder, unlike Pressly, continued in his administrative functions as president of PCOM until 1909. He remained in Philadelphia, and his private practice in osteopathy increased, especially after he took over some of the patients from his former partner Mason Pressly. He continued to exert a great influence on the osteopathic college of which he was cofounder and became an important figure in the osteopathic profession. He was an ardent lobbyist for the profession in the state capital and variously held the presidency of the state and national osteopathic societies. He was president of the State Board of Osteopathic Examiners from 1909 to 1930. In 1929 the college awarded him the honorary degree of Doctor of Science while the American Osteopathic Association gave him its Distinguished Service Certificate for "championing high standards of education."

Oscar John Snyder, referred to with respect and affection simply as "O. J.," died in Philadelphia on June 14, 1947, and is interred at West Laurel Hill Cemetery. The O. J. Snyder student prize, the Snyder Alumni Achievement Award, and the Snyder Memorial



Philadelphia College of Osteopathic Medicine (1905–1973).

Library are but a few of the numerous memorials that commemorate this dedicated osteopathic physician. Each year on Founder's Day there is a wreath-laying ceremony at his graveside.

In line with the holistic philosophy of osteopathy, the student first took comprehensive courses in what we now designate as the basic medical sciences. As phrased by Snyder "no anatomical structures are disregarded, no physiological properties are termed inconsequential, and no symptom is too small to have a cause." Special attention was paid to anatomy, and even today anatomy is taught in greater detail than in most allopathic medical schools. Much emphasis was also placed on a good knowledge of physiology: the early college cata-

logue stated "In physiology the student lays a solid foundation for his advanced work in diagnoses and treatment of disease, because all disease is simply a disturbance of functions or derangement of structure of some part or parts of the body . . . an osteopath who knows physiology understands how each organ and part of the body should work."

Reinforcing the student's study of the normal as well as the disordered skeletomuscle system, emphasis was placed on nerve and muscle physiology and biomechanics. Physiology of the nervous system was considered important enough to be given as a separate course. In an early college catalogue, the statement is made that "this neurophysiology course and the accompanying one in anatomy are, because of their importance, among the completest and most thorough in the curriculum."

In the early years admission to PCOM was open to qualified high-school graduates without consideration of race, color, or sex (of the first two D.O. graduates, one was a woman). Later, one year of attendance, soon to become two years, at an approved liberal arts college with emphasis on courses in chemistry and physics were required. To assure that students were adequately prepared for admission, a Pre-Osteopathic School was established on the PCOM premises. Instruction was given in chemistry, physics, biology, and English. It was in this latter course that the student learned, probably for the first time, that the word "osteopathy" does not mean bone pathology. Rather, the word is derived from the Greek "osteon" and "pathos", literally translated as "bone pathos", meaning "experience, emotion, or suffering referred to bone." No pathologic processes is implied.

Other requirements soon lengthened the Pre-Osteopathic School to two years. The Pre-Osteopathic School was finally closed when PCOM requirements for admission were raised to graduation from a fully accredited four-year liberal arts college and a designated minimum number of hours of course work in biology, physics, chemistry, and English.

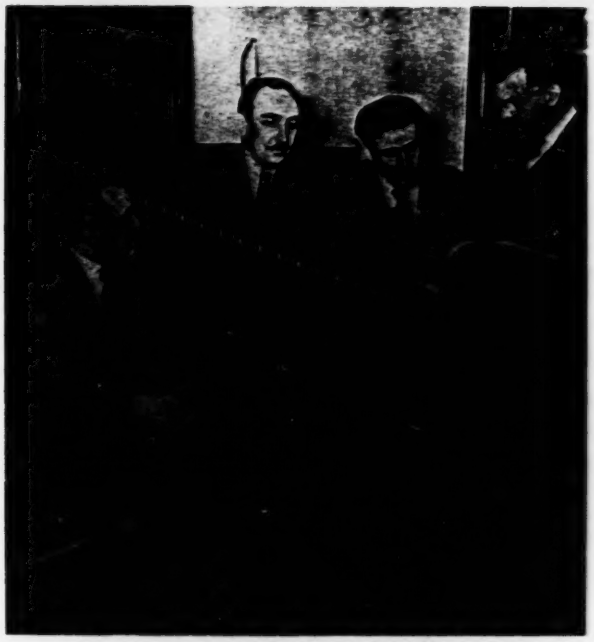
During the first year of its existence, when Pressly was the sole instructor, the school year was for five months, November 1898 to March 1899, reflecting the origin of osteopathy in a midwestern agricultural setting. This was also the length of the school year at the start of the Still's American School of Osteopathy. After Snyder joined Pressly, the instruction period was raised to eight months, then ten months, and soon two years of nine months each were required for the D.O. degree. By 1906 a full three years of nine months each were mandated. However, while a D.O. degree obtained after three years of study was accepted by Pennsylvania and most state licensing boards, those of New Jersey, New York, and Delaware required a full four-year curriculum. Since many of the students attending PCOM came from these states and intended to return there to practice, the answer was to provide for these students an additional year of "graduate work" consisting of lectures and laboratory work, particularly physiology. No thesis was required and no postgraduate degree was given.

Strong pressure was being exerted by the Pennsylvania allopathic and homeopathic physicians to require that all medical practitioners come from a four-year school. Reading the handwriting on the wall, PCOM in 1911 became the first osteopathic college to institute a regular program of four full years of study. The first class began in 1912. This increase in instruction time was strenuously resisted by the other osteopathic schools, but they soon fell into line, albeit reluctantly. (By contrast, the first allopathic medical school to undertake a four-year M.D. program was also located in Philadelphia, the Jefferson Medical College, in 1885.) By adopting a four-year program with the same entrance requirements as the "regular" medical schools, PCOM became the leader in education among the osteopathic colleges in the country. Its standards of educational requirements became the highest and its course work the most comprehensive. Meeting the educational requirements of New York and Pennsylvania, states with the strictest medical licensure requirements, was important, since the greatest single objection to osteopathy advanced by organized allopathic societies was now removed.

Early Physiology and Faculty

An unexpected benefit to PCOM was derived from its Pre-Osteopathic School. The instructors in this school were all well trained in their respective subjects. Many of them, especially the instructors in physics and chemistry, elected to become students in the osteopathic medical program as well. After receiving the

Student physiology laboratory, 1916 (*left*) and 1930 (*right*).



William Balwin, D.O., and his staff, Drs. Weisbecker, Messey, and Kent (ca. 1938).

D.O. degree, and frequently even before graduation, a number remained at PCOM as instructors, some rising through the ranks to become professors. Those trained in physics were especially attracted to physiology. One such person was William Baldwin, Jr., who started as Instructor of Physics and became Professor of Physiology and Chairman.

An instructor in physiology usually taught one or two other courses: this was common practice in all the osteopathic schools as well as the allopathic schools that were founded before 1900. The rank of an instructor was not the same in each of his teaching disciplines and frequently fluctuated within a department. For example, the catalogue for 1917–1918 gives Peter H. Brearly in the faculty roster as Professor in General Physiology, but simply as Instructor in that portion of the same catalogue that described course content of physiology.

The course in physiology taught by Mason Pressly and his immediate successors was wholly descriptive. The course by William S. Nicholl in 1910 consisted of didactic lectures in general physiology illustrated by blackboard drawings and stereopticon. Neurophysiology was taught as a separate course by D. S. B. Pennock. Both courses were presented strictly from an osteopathic point of view and laboratory consisted of demonstrations. Some material on cellular physiology was included in an introductory course in biology. The total allotted time was much less than that devoted to anatomy but equal to the combined time taken up by hygiene, bacteriology, and biochemistry.

William Nicholl had wide-ranging interests in medicine. During his tenure at PCOM he taught almost every subject in the college curriculum but his major teaching contribution was to physiology. He was responsible for beginning a separate ENT department in 1916: in this he was assisted by Peter Brearly who later would succeed him as head of the physiology department. The *Philadelphia Ledger* for March 26, 1913 reported that at the time of the merger of the Philadelphia College of Osteopathy with the Osteopathic Hospital of Philadelphia the largest block of corporate stock, originally owned by Pressly and Snyder, was turned over by William Nicholl. He retired as chairman in 1915 and died in 1946 at age 70.

The same total time was devoted to physiology from 1915 to 1928 when Peter H. Brearly was head of the department. A course designated "Experimental Physiology" was introduced for fourth-year students in 1924: the following year the course was renamed "Clinical Physiology." It was designed to show "practical applications by experiments on living subjects of the principals of physiology which have been studied in the textbooks." The textbooks were Howell and also Brubaker: the living subjects were fellow students. Later, around 1937, the term "Experimental Physiology" would be revived to designate a course in pharmacology to be given by the Physiology Department.

The 1920 college catalogue lists Peter Brearly as Professor of Physiology (General) and Charles H. Heard as Professor of Nervous Physiology. The latter had seen service during World War I with the British Hadley-Page Bomber Squadron. Robert Lichtenthaeler was Associate Professor of Physiology. Lichtenthaeler held similar rank in three other departments. He was not a D.O. His educational background was quite varied from that of his fellow instructors. He had taken B.S. and M.S. degrees from University of North Carolina and an Sc.D. degree from Jefferson. He had done research in the Universities of Florida, Rhode Island, Penn State, and the University of Pennsylvania. He was probably the first PCOM instructor to hold membership in the Philadelphia Physiological Society (believed by some to be the oldest physiological society in the country) and in the American Chemical Society. In addition to participating in teaching the first- and second-year courses in physiology, he was responsible for a course to the fourth-year class on "Experimental Physiology: the application by experiments on living subjects the principles of physiology which have been learned in the text books." The textbook was Howell and the subjects were frogs and turtles.

The 1925 catalogue shows four other members of the teaching staff in physiology. A somewhat unusual addition was a course in psychology given by H. McD. G. Bellow, but his course soon was transferred to another

Left: Peter H. Brearly, D.O., Professor of General Physiology (1916–1928); *right*: Edward A. Green, D.O., Professor of Physiology (1928–1938).

department and became the nucleus of a Department of Psychiatry. Perhaps the most significant new member was Edward A. Green, D.O.; within three years he would become Chairman of the Department.

Green had started directing a course in laboratory physiology for two years before he became Chairman; the catalogue for 1928–1929 shows that he then increased the number and variety of experiments.

In 1928 Brearly left the Department of Physiology to become Professor of Osteopathic Techniques: he also continued in his private practice until shortly before his death in March 1947. Dr. Green, who was professor of Physiology as well as Professor of Anatomy relinquished his anatomy post to become Chairman of the Department of Physiology and to continue as College Registrar.

Beginning in 1933 a number of changes were instituted that affected physiology. Because of the interrelations between structure and function, a point strongly emphasized in osteopathy, many of the staff in physiology were found also competent to be preceptors in anatomy. Although the two subjects were taught as discrete units, the close ties exhibited through the years gave the quasi appearance of constituting a single department. This arrangement may have given anatomy instruction the benefits of a more "functional" approach but proved unsatisfactory for an ever-expanding college.

In the period extending from the time that Pressly left PCOM to the time of Brearly's retirement—a span of about 25 years—attention of physiology was largely focused on neuromuscular and skeletomuscular functions. But other functions were not neglected; the whole body was considered. It is obvious, however, that neuroskeletomuscular systems began to receive less attention in the physiology department as they became adjuncts of the osteopathic department teaching.

Systems that had received less attention were now given more consideration: the statement made in the 1924 college catalogue was fulfilled:

> In physiology, the student lays a solid foundation for his advanced work in diagnosis and treatment of disease, because all disease is simply a disturbance of function and derangement of structures of some part or parts of the body . . . an osteopath who knows physiology understands how each organ and part of the body should work.

Beginning of Pharmacology

At first Green's physiology course was a continuation of the schedules set up by Brearly, and consisted of lectures, "recitations," and laboratory. The lecture subjects covered all functions except neurophysiology, which was presented as a separate course. Recitations were combinations of oral examinations and conferences, whereas laboratory at first was demonstrations presented by the faculty. Later, as more equipment such as kymograph and electric coil stimulators were acquired, there was student participation.

An action by Green made before his retirement was the introduction in 1936–1937 of a course he designated as "Experimental (Pharmacology)." This may have been the first instance of the use of the term "pharmacology" in the PCOM catalogue. This course of 112 hours was described in the catalogue thus: "(The course is planned mainly with the action of . . . antiseptics, antidotes, anesthesia, and narcotics. A distinguishing feature of the instruction is the comparative study of accepted osteopathic procedures with the general use of drug medication. Through comparison, principles of osteopathy are shown not only to be sound but far-reaching in their application)."

This course appears to have been introduced because the State of New Jersey Board of Medical Examiners required for licensure that the student peruse a minimum of 160 hours of pharmacology and a great number of the PCOM graduates chose to practice in New Jersey. The deficit was made up by a course of 64 hours in toxicology given separately by the Department of Chemistry and Toxicology.

Green, who retired in 1938 as Emeritus Professor and died in 1946 at age 70 years, was succeeded as Director of the Department of Physiology by William Baldwin, Jr., D.O., who had recently been promoted to Associate Professorship. Baldwin first had come to PCOM as an Instructor in Physics in the Pre-Osteopathic School. He was made Demonstrator in Physiology in 1933 and with Green gave a course in osteopathic applied physics. At this time he entered the D.O. program. In 1939 he was made a full professor and in 1940 received the D.O. degree. He left PCOM in 1958 to become Chief of Internal Medicine at Memorial Hospital in York, Pennsylvania, at a substantial increase in income. As of 1985, Baldwin is the only surviving former chairman of the department and now lives in Baltimore, Maryland.

Under Baldwin's direction a number of significant changes were instituted in physiology. A course designated as Special Physiology replaced the psychology and nervous physiology courses: emphasis was on integration of the nervous and endocrine control systems and included student laboratory experiments.

An even more important change was the introduction of a broad course of lectures and laboratory work in pharmacology. This extended course was given for the first time in 1938. As described by Baldwin "a distinguished feature of the instruction throughout is the comparative study of accepted osteopathic procedures *with* the use of general drug medication." Notice the acceptance of drugs as supplementing osteopathic procedures. Two instructors knowledgeable in pharmacology were added to teach the course, Sam Levin, Ph.D., D.O., and Joseph Massey, M.D. To reflect the emergence of pharmacology as an integral part of the osteopathic student's instruction the department was renamed Department of Physiology and Pharmacology.

Even before 1940, however, the students received instruction about the properties and uses of drugs but probably not pharmacodynamics. In actuality the subject was camouflaged by being hidden in the "Department of Supplementary Therapeutics." This "department gives the foundation and instruction in those phases of therapy aside from manipulative procedures in general osteopathic practice . . . not distinctive of the osteopathic school." The pharmacologic considerations were toxicology (22 hours), biologics (12 hours), anesthetics (16 hours), and prescription drugs and prescription writing (34 hours) for a total of 84 hours. (As noted before, additional lectures in toxicology were given in the Department of Chemistry and Toxicology.)

The introduction of pharmacology into the curriculum was not met with favor in some of the other osteopathic colleges, nor was it wholly accepted by the PCOM faculty. This was underscored in the address that Charles S. Green, D.O., of New York, who had been trained by A. T. Still, gave at PCOM on Founder's Day, February 16, 1939. He feared that osteopathy would undergo the fate of homeopathy—"absorption by the allopaths." "The various medical (allopathic) journals are as replete with articles on . . . manipulative surgery as our own . . . Slowly, piece-meal, the osteopathic child is being kidnapped. . . ." Knowledge of pharmacology and materia medica now being taught in the osteopathic college is being "regarded as a substitute . . . for the art of osteopathic practice." The child must be rescued.

An important component of Baldwin's course in physiology was student laboratory work. Although experiments on animals were limited to the frog and turtle, students performed numerous experiments on themselves and on each other. The laboratory physiology notebooks and manuals from PCOM compare very favorably with those from the Philadelphia allopathic medical schools of the same period. Additionally there were a number of experiments designated as "osteopathic physiology" such as mechanisms of movement of the vertebrae. Whenever possible Baldwin's experiments were supplemented by regularly scheduled demonstrations by the staff or invited guests.

Spencer Bradford, D.O., class of 1942, joined the Department of Physiology as an instructor in 1943 while remaining in private practice for a number of years. His office was not far from Temple Medical College, which offered him the opportunity to do research in physiology with Temple's Professor M. H. Oppenheimer. In 1958 he was appointed Associate Professor and Acting Executive Officer of the Department and designated Professor and Chairman in 1961. For his research at Temple he was awarded the Master of Science degree by PCOM.

Spencer G. Bradford, D.O., M.S., Professor of Physiology and Pharmacology (1960–1976).

Bradford extended the student laboratory physiology by introducing new subjects for experiments, such as dolorimetry (tail-flick method in the rat), perimetry, nystagmus, electrocardiography, and cerebrospinal circulation. A few years later, to combat the rising costs of laboratory work and to counter a trend then prevailing in most medical schools to reduce the number of experimental animal laboratory sessions, televised laboratory instruction was introduced. An audiovisual center, fully equipped to produce films and audiovisual tapes and cassettes and staffed with trained personnel, had been established in the new building on Bradford's behest. In addition to those produced by the physiology staff, audiovisual tapes and films were also rented or borrowed from several sources and transmitted into the student laboratory for viewing on T.V. closed-circuit monitors. After a number of sessions and different formats of presentation, Bradford concluded that video tapes, no matter how well done, were suitable only as educational reinforcement and could not serve as substitutes for hands-on laboratory experience.

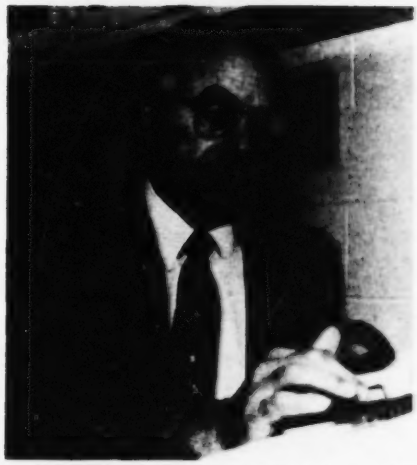
Bradford then acquired more modern student laboratory equipment. The electric ink-writing kymograph that had replaced the classical smoked paper spring kymograph now in turn was replaced by the multichannel recorder with pressure, volume, and flow transducers. The induction coil gave way to the electronic stimulator, and litmus paper to electronic pH meters. A fully equipped electron microscopy laboratory with scanning and transmission electron microscopes was also established for student instruction.

Dr. M. H. F. Friedman, on retirement from the Chair of the Department of Physiology at Jefferson Medical College of Thomas Jefferson University came to PCOM as Visiting Professor of Physiology and Pharmacology on the invitation of Dr. Bradford. He was asked to take charge of student laboratory instruction: he was assisted by recent graduates with Ph.D. degrees who had become junior staff members in the department.

Present Physiology Faculty

Domenic Anthony DeBias in 1975 succeeded Dr. Bradford as Professor and Chairman of the Department of Physiology and Pharmacology. He came from Thomas Jefferson University where he had been Professor of Physiology and Coordinator of the Anatomy-Physiology curriculum courses. Born in Tresckow, Pennsylvania, he attended Temple University where he obtained A.B. and M.A. degrees with majors in biology and chemistry. In 1956 he received the Ph.D. degree in physiology from Thomas Jefferson Medical College. His research interests have been in endocrinology, respiratory physiology, and the effects of chronic exposure to carbon monoxide on the cardiovascular system. In recent years his attention has focused on experimental myocardial infarction and the somatic component of myocardial infarction in human clinical cases.

In addition to directing the course in physiology for medical students, Dr. DeBias inaugurated and coordinates an interdisciplinary course in nutrition given by



Domenic A. DeBias, Ph.D., Professor of Physiology and Pharmacology (1975–).

the physiology and other departments as well as guest nutritionists and internists. PCOM is one of a few medical schools that offers a required course in nutrition that includes both laboratory work and lectures.

New multichannel recorders (Grass Polygraph) were acquired to extend the range of student experiments. Last year the use of computers in the student laboratory was introduced and will now become routine. Now being tested is the feasibility of using the young pig in student cardiovascular experiments.

Structural innovations have been made to increase the instructional and research capabilities of the department. A departmental library-conference room, an animal operating room, a completely shielded fluoroscope room with fluoroscope, a photography laboratory and, most recently, a laser laboratory have been added to the laboratories and staff offices.

In 1983 and again in 1984 the laboratories of the Department of Physiology were the site of a series of workshops on technology of lasers and their use in medicine. These were sponsored jointly by PCOM and the Institute of Applied Laser Surgery and featured CO_2, Nd-YAG, Argon, and dye lasers. The sessions were unique in that they provided hands-on experience for several hundred M.D. and D.O. physicians from the United States and Canada. The laboratory work was coordinated by Dr. DeBias and Dr. Charlotte Greene who had joined the department in 1975.

Physiologic Research

Of the three major objectives of a medical school—education, health care, and research—the least attention at PCOM was given to research. This was recognized in some quarters and many plans were advanced for rectifying the situation. Almost all staff members however, even those in the basic sciences, including the chairmen, were in private practice, which provided most of their income. A few studies were made, the majority by Lloyd, but these were the exceptions.

An attempt to correct the deficiency was made in 1932 by establishing a separate department of research. Frederick A. Long, D.O., Professor of Osteopathy was designated the Professor of the Department and Director of Research. The department consisted of Dr. Long, an assistant director, and a secretary. Occasionally one or two technicians and D.O.'s were also included. "Workers in other departments that were provided with the necessary equipment carried out certain research projects under the supervision of the Director of Research." Long was not a trained physiologist or a member of the department; nevertheless for several years his was the only investigative work. One study in collaboration with the Department of Physiology was "Effect of manipulation on the vascular status in the hand (plethysmograph) measurements." Others were concerned with blood pressure, heart rate, respiration, and reflexes as affected by manipulative procedure. As Dr. Long later acknowledged in an annual report "Such experimental studies reached no large proportions. . . ." Numerous review articles based on recent advances in research reported in the literature were published in osteopathic journals but few contributions of original investigations of their own were reported. (These review articles, such as "Today's Concepts in Endocrinology," "Certain Factors in Referred Pain," and "Bases for Coronary Disease," did carry out one function of the Medical College, namely education.)

The principal aim of the college continued to be fulfilling the original purpose of its founders—the training of osteopathic physicians. The output of research remained dismal. This was not due to a lack of interest or research ideas as much as a matter of definition of priorities and lack of training in research methodology. Osteopathy to most was still new and had to be proven as an acceptable system of medicine. This left little time for investigative work by the faculty, all of whom had private patients. What research that was done in this climate quite naturally was directed to problems of osteopathic interest. Evidence on the efficacy of a procedure was based on the patients' subjective reactions and was mainly anecdotal. Control studies were few.

Of major importance to the whole PCOM institution have been Dr. DeBias' successful efforts to reduce the gap between the clinical and basic science departments. This dichotomy, due more to impaired communications than lack of interest, is to be found in most medical schools, allopathic as well as osteopathic, and is most evident where the clinical and basic science faculty have quarters in separate buildings. Dr. DeBias and other members of the Physiology Department have in progress numerous collaborative studies, both experimental and clinical, with members of other disciplines. The Departments of Surgery, Urology, Otolaryngology, Medicine and Osteopathic Principles have been active participants in joint studies. A number of exhibits at medical society meetings have been made and reports in both osteopathic and allopathic journals have been published.

With the exception of Dr. M. H. F. Friedman, all of the present full-time members of the Physiology Department joined the PCOM faculty after Dr. DeBias became Chairman. All showed ability to communicate with the medical students and experience in or potential for biomedical research.

Leonard S. Rubin joined the department in 1981 as Professor of Physiology. He obtained a B.A. degree from City College of New York and Ph.D. from New York University. He is primarily interested in neurophysiology, especially the autonomic nervous system,

the immunoglobulin isotype expression in common migraine, and neurologic correlates of stress.

Henry William Hitner, B.S. (Moravian), M.Ed. (West Chester State), M.S., Ph.D. (Hahnemann), spent several years in research in pharmaceutical industry and teaching undergraduate college courses in biology and physiology before coming to PCOM in 1977. He is Associate Professor of Physiology and Pharmacology and Vice Chairman. His major interest is drug addiction and abuse, and the metabolic aspects of shock. With Dr. Mahalik he is studying the evaluation of antihypertensive drugs by use of the placental blood flow technique. Charlotte H. Greene, B.S. (West Chester State), Ph.D. (Jefferson), was Director of Metabolism Laboratories in the Clinical Research Center of Philadelphia's Childrens Hospital when she came to PCOM in 1975. Now an Associate Professor, she is very active in studying experimental myocardial infarction, cardiac effects of fluoride, and somatic correlates of cardiac dysfunction of osteopathic significance. Walter C. Prozialeck, Associate Professor, came to PCOM from the Medical College of Pennsylvania where he was a postdoctoral fellow in pharmacology. He holds a B.S. degree from Juniata College and a Ph.D. degree from Jefferson Medical College. His research interests include neurotransmitter receptors in the central nervous system, action of antipsychotic drugs, and pharmacologic regulation of calmodulin.

Michael P. Mahalik, B.S. (Penn State), M.S., Ph.D. (Temple), Assistant Professor, joined the faculty in 1983. His chief interest is in experimental teratology. Susan Pointon Miska, B.S. (St. Lawrence), M.S., Ph.D. (Rochester), was a postdoctoral investigator and staff member in experimental teratology at the National Center for Toxicological Research when she came to PCOM in 1982 as Assistant Professor. Her current studies are on the influence of β-adrenergic blockers on plasma triglyceride lipoproteins and high-density lipoproteins cholesterol component. Donna M. Moisey, B.S. (University of Scranton), Ph.D. (Medical College of Pennsylvania), Assistant Professor, came to PCOM in 1983 after postdoctoral work at the Bockus Research Institute of Graduate Hospital. Her research is on the regulation of ion transport in vascular smooth muscle and on pregnancy-associated changes in vascular neuroeffector complexes. Frederick C. Monson, B.A., Ph.D. (Lehigh), is Assistant Professor of Physiology and Director of the Electron Microscopy Laboratory. He came from St. Joseph's University where he studied the development of the Sertoli cells of the reproductive system. His major research now is the electron microscopic structure and life cycle of rickettsial organisms.

M. H. F. Friedman, B.Sc. (McGill), M.A. (Western Ontario), Ph.D. (McGill), has full-time duties that include student teaching (lectures and laboratory) and research. At PCOM he concluded an extensive comparative study by electron microscopy of the structure of the vertebrate tongue, pharynx, and esophagus. An experimental study of viscerosomatic and somatovisceral reflexes of interest to osteopathic medicine followed. Currently he is studying the patterns of recovery of the heart rate immediately after termination of treadmill exercise under different protocols.

Following a visit of inspection of PCOM in 1939 an authority on medical education reported that he "found little evidence of original investigation which is the real motivation of any scientific institution." To this were added pleas that PCOM consider research, such as that in the editorial of March 1939 in the *Osteopathic Digest*, "The profession has not realized how important a problem research has become. Our faculty must be committed ... to study ... the sciences underlying medicine and osteopathy.... The future of osteopathy is linked materially with research."

None was more perceptive of the need for PCOM to undertake research than Dean Holden, as expressed forcibly in this terse communication in November of 1942:

> This is wartime ... There is no chance to win (recognition) as an independent school of the healing art, unless we rise to the occasion. We are not indispensible. The profession must realize that it is a minority group. We have not as yet proved our case ... if we keep knocking at official doors we must have ... irrefutable information concerning scientific and technical work well done. The osteopathic profession *must be made* to realize ... that the indispensible factor ... for universal recognition is ... a greatly intensified program of osteopathic research.

Minutes of the Executive Faculty meetings bear numerous entries discussing problems of research productivity at PCOM, including statements such as "the prestige of PCOM is measured in terms of osteopathic research ... are we contributing properly? Are we publishing properly?" Most ardent advocates were the basic science department representatives, especially physiology.

Although the word research for most still remained a shibboleth, physiology and biochemistry were the most active departments. In those years, however, few members on the faculty had research training. In physiology there were numerous interesting experiments in hematology, muscle dynamics, and reflexology. These were reported orally at departmental and faculty meetings, but few papers were published.

Only after 1973 did research in physiology become more productive, for which there are several explanations. The college had moved into a new building that offered suitable space for laboratories and ancillary services, newer equipment was made available, institutional funding was forthcoming, and American Osteopathic Association research grants gave needed support. However, the greatest single factor was the recruitment of a faculty with research training and potential to do investigative work. In the 1960s almost every faculty member of the physiology department was a D.O.; by 1974 there were 6 with D.O. degrees and 8 with Ph.D. degrees, and in 1984, 10 of 11 members had Ph.D. degrees. This had a ripple effect that spread to a number of clinical departments and led to numerous collaborative studies with the department of physiology. It is of interest that most of the allopathic medical schools established before 1900 had experienced similar situations in physiologic research at corresponding stages in their development.

The new building brought together all the basic science disciplines and provided quarters for an enlarged medical library. Student classrooms and laboratories were occupied only to 4 p.m. To better utilize the new

facilities and increase student enrollment, a short-lived program known as the Extended Day Program was instituted. The students selected for this program had met the same admission standards as the other students but could attend school only from 4 p.m. to 10 p.m. daily during the first two preclinical years. This provided them with the opportunity to be gainfully employed during the day. In the third and fourth years, the clinical years, they became full-time day students.

Opportunities for student participation in research work in physiology were listed in all the annual PCOM announcements beginning in about 1920. However, there appears to have been little interest beyond some students writing "research reviews." Even when Baldwin and later Bradford arranged for stipends for student summer research work, there were few applicants. This is understandable in view of the actually small number of research activities by the faculty. In the mid-1970s, when DeBias became Chairman of the Department of Physiology and Pharmacology, the conditions for student research improved. As indicated above, research-oriented faculty was increased, and each faculty member readily attracted two or three dedicated students to become junior members of a research team. Some students developed skills to become exhibitors at scientific meetings. A number of these students after graduation entered into careers in academic medicine.

Both Baldwin and Bradford encouraged research by staff and students but were not active themselves. Both men published review articles in osteopathic journals on recent advances in physiology that were of interest to the osteopathic physician. Baldwin instituted regular staff meetings at which members of the department presented their research findings or reviewed current research journals. These "symposia" became the forerunner of the C.M.E. meetings guided by Bradford. The symposia were developed originally for residents at PCOM and area hospitals, but they were well attended by D.O. and M.D. physicians in practice, who found them useful for learning about new research advances. At some point they became interlaced with the courses given in the Postdoctoral Studies Division.

Division of Graduate Studies

The "graduate study" program introduced to provide a fourth year for those D.O. graduates who wished to practice in states that did not recognize a three-year curriculum for licensure languished after PCOM adopted a regular four-year schedule for the D.O. degree to begin in 1912. In 1933 new impetus was given for a graduate program but this time the thrust was in another direction and toward other objectives. Established was a graduate degree program open only to a D.O. who intended to pursue a career in academic osteopathic medicine. A good osteopathic school record and membership in the American Osteopathic Association were requisites. On completion of a prescribed course of study tailored to fit the candidates needs and submission of an acceptable thesis based on his research, the student was awarded a Master of Science degree in his specialty, for example, M.S. (Obstetrics) or M.S. (Urology). The Division of Postgraduate Studies attracted many osteopathic physician students. In the academic year 1960 alone there were 16 M.S. degrees awarded, all in clinical areas. There is record of only two M.S. (Physiology) degrees having been given earlier to physiology teaching faculty.

Though in the right direction, the M.S. program was not an academic program as much as it was professional, and therefore it was considered inadequate and inappropriate for physiology. This was the sense expressed earlier (on May 7, 1952) by Dr. William Baldwin when he announced that consideration was to be given to the needs for establishing a graduate school. Five years later (December 1957) it was recognized that the plan would have to be deferred until enough trained Ph.D. physiologists had been included in the department and special equipment, space, and animal facilities suitable for research programs were provided. The topic kept coming up on many occasions, but no action was taken.

In 1974, Dr. Friedman was asked to review the feasibility of establishing an academic graduate degree program in the basic sciences. By this time an adequate staff of research-trained physiologists, pharmacologists, and other basic science personnel were on hand. The new building provided ample space for research laboratories and animal quarters. Acquisition of modern research equipment had become an ongoing event. Drawn up in accordance with the guidelines recommended by the Council of Graduate Schools in the United States, the report submitted in 1975 favored establishing a graduate division with a limited initial enrollment. Guidelines were laid for administration of the division as a unit separate from the D.O. program. Action was again deferred.

In June 1979 Dr. DeBias was appointed Assistant Dean of the Basic Sciences and the problem fell to him. A site visit was made by the Pennsylvania Department of Education in the Spring of 1982 and approval given for further study of the program. Dr. DeBias then appointed a committee from the Basic Science Departments to embody a program and in the Spring of 1985 this program was submitted to the College Administration.

The foregoing is an abbreviated presentation of a more extensive history of physiology at PCOM to be deposited in the archives of the American Physiological Society. The author is grateful to Maggie Ferguson and Christine Donovan for their invaluable assistance and to many faculty members for their cooperation.

History of Physiology at University of California, Davis

A. H. SMITH, E. M. BERNAUER, A. L. BLACK, R. E. BURGER, J. H. CROWE, J. M. HOROWITZ, G. P. MOBERG, and E. M. RENKIN
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The Davis campus had its origin in a bill for a "University Farm School" that was passed by the legislature and signed by the governor in 1905, after several years of activity, particularly on the part of Peter J. Shields. Shields [1862–1962] was a member of the state legislature and a Superior Judge. He is considered to be the father of the Davis campus. The principal campus thoroughfare, the main campus library, and a grove of oak trees (containing 80 kinds) are named after him. He maintained close contact with the campus and the students throughout his long life. On several occasions the student body chose him to be Grand Marshall for their annual festival "Picnic Day," and the student year book (*El Rodeo*) was dedicated to him four times. An LL.D. degree was conferred on him at the Davis commencement in 1955. Shields was very interested in the development of California agriculture, because he had served as Secretary of the California State Agriculture Society.

By 1899 it had become apparent to Shields that the university should have a farm so students could have direct experience with agriculture. Although there was a College of Agriculture at Berkeley, its curriculum was purely academic and largely confined to the study of botany and agricultural chemistry. After considering 50 sites in the central valley, 778 acres were purchased (for $104,250) that were formerly part of the prize-winning Jerome C. Davis farm. This is the basis for the name of the campus and adjacent town (Davisville until 1917). Subsequent purchases enlarged the original University Farm to 1,000 acres in 1930 and to the present 4,700-acre Davis campus in the 1950s.

The location of the University Farm was hotly contested among local booster groups. Factors in selecting Davis were the quality of the soil, availability of water, and particularly its location on the principal railroad, with frequent service to the bay area, enhancing contact with the Berkeley campus. The railway continued to be the principal line of contact between the two campuses until World War II.

The Farm School opened in 1908, offering instruction in "the principles and practise of agriculture." The initial faculty consisted of Arthur M. Claghorn, principal, and four professors (the student enrollment was 28).

In 1909 academic instruction was added for students in the College of Agriculture at Berkeley, who spent a semester or a year at the University Farm. In 1922 the University Farm became the Branch College of Agriculture of the University of California, with H. E. Van Norman as Director at Davis and C. B. Hutchison as Dean at Berkeley. By this time academic offerings had become sufficiently enlarged to admit students at the freshman level. The academic scope at Davis continued to enlarge, but with an emphasis on biological science as a result of its agricultural heritage. In 1958 Davis became a general campus, with S. B. Freeborn, an entomologist, as Chancellor. Currently the Davis campus has Colleges of Agriculture and Environmental Sciences, Engineering, Letters and Sciences; Schools of Administration, Law, Medicine, Veterinary Medicine; and a Graduate Division. The campus also has the California Primate Research Center, the Crocker Radiation Laboratory, the Institute of Ecology, and administers the Bodega Marine Laboratory. In 1985 the enrollment was 14,600 undergraduate, 5,200 graduate, and 1,900 professional students.

Early Development of Physiology

In 1926 George H. Hart became Chairman of the Division of Animal Husbandry at Davis and proceeded to reorganize its teaching and research activities. He believed that further progress in animal agriculture required putting it on a scientific basis, both in teaching and research. To achieve this, he brought H. H. Cole (physiologist), Max Kleiber (nutritionist, physiologist), Harold Goss (biochemist), and Paul W. Gregory (geneticist) to the Animal Husbandry faculty. It was his intent that they offer academic courses in their disciplines as part of the Animal Husbandry curriculum as well as collaborate in research with production-oriented members of the faculty.

George H. Hart [1882–1959] received a V.M.D. degree from the University of Pennsylvania in 1903 and an M.D. degree from George Washington University in 1908. After service with the U.S. Bureau of Animal Industry and as Los Angeles City Veterinarian, he joined the faculty of the Veterinary Science Division at the University of California, Berkeley (UCB) in 1917, where he engaged in research on animal diseases. Later he transferred to the Davis campus, where he was Chairman of Animal Husbandry (1926–48) and Dean of the School of Veterinary Medicine (1948–54). In 1928 he organized and taught the first mammalian physiology course on the campus and was assisted in the laboratory by H. H. Cole.

Harold Cole [1897–1978], a native of Wisconsin, attended the University of Wisconsin, earning a B.S. degree in 1920. His college years were interrupted by service in the U.S. Navy (1917–18), being on board the battleship U.S.S. Kentucky at the War's end. After three years on the family dairy farm, he enrolled at UCB, where he earned an M.S. degree in 1925. His studies included research projects with George Hart and Herbert M. Evans, and on completion he became a research assistant to Dr. Evans investigating the estrous cycle of

the dog. In 1926, Cole entered the University of Minnesota and received a Ph.D. degree (Physiology) in 1928.

Dr. Cole returned to California in 1928, and in 1929 he joined the faculty at Davis. He continued teaching the mammalian physiology course until 1953, as part of the newly organized curriculum in Animal Husbandry. He also organized a research program that emphasized the physiology of reproduction in domestic animals. An early achievement, in collaboration with Dr. Hart, was the discovery of Pregnant Mare Serum Gonadotrophin (PMSG), which was reported in 1930. This was a major contribution to the understanding of pituitary-gonadal relationships in reproduction. He continued studying PMSG for the next 25 years in collaboration with colleagues and graduate students, the results being reported in a series of 25 papers.

Another of Dr. Cole's research programs dealt with ruminant digestion and particularly the physiological basis of bloat. These involved studies of the processes of eructation, regurgitation of the cud, and the influence of feeds on the production of rumen gases, carried out with a series of cows with fistulated rumens. He concluded that to prevent bloat, diets must contain a sufficient fiber (scabrous) content to elicit eructation reflexes. He also investigated the mechanism of increased maternal growth during pregnancy and, with Max Kleiber, studied the metabolic rate of rats with body size increased by growth hormone administration and by genetic selection, and the relationship of body size to metabolism in fetuses.

From 1953 to 1960 Dr. Cole served as Chairman of the Department of Animal Science. While chairman he continued his physiological research, largely in collaboration with graduate students. In 1964 Harold Cole became Professor Emeritus, receiving an LL.D. degree at the 1965 commencement. During his career, he received other honors from both agricultural and academic bodies: Faculty Research Lecturer (1944), the American Society of Animal Production's F. B. Morrison Award (1952), Golden Fleece (1960), American Society of Animal Science's Award in Physiology and Endocrinology (1963), Outstanding Alumnus Award from the University of Minnesota (1968), and Hartman Lecturer to the Society for the Study of Reproduction (1974). In 1969, a major research laboratory on the Davis campus, The Harold H. Cole Facility (for the study of the physiology of large animals), was dedicated. In 1978 the Second International Symposium on Equine Reproduction was dedicated to him.

Max Kleiber [1893–1976], a native of Zurich and son of an agricultural chemist, grew up in a rural environment near Basel. After a year's study at the Federal Institute of Technology, Zurich, he emigrated to Canada with two friends, where they established wilderness homesteads. Kleiber took a textbook of calculus with him, which he studied in the evenings. After a year, Kleiber was ordered home for military service as a Captain in Artillery in World War I. During this service, and because of some scandal in the Swiss Army Command, he became a formal pacifist. This led to his dismissal and a four-month prison term. While in prison he read Rubner's book *Die Gesetze des Energieverbrauchs bei der Ernahrung*, which kindled his interest in bioenergetics. After his release he reentered the Federal Institute of Technology, graduating in agricultural chemistry in 1920. He then entered graduate study with Dr. Georg Wiegner, a colloid chemist, and was awarded the D.Sc. degree in 1924. His thesis was on electro-ensilage. Dr. Kleiber then entered postdoctoral study, becoming a Privat Dozent (1926) with a thesis "The Energy Concept in the Science of Nutrition."

Dr. Kleiber continued his studies in the energy metabolism of animals until 1929, when he was invited by Dr. Hart to come to Davis and establish a laboratory for the study of energy metabolism of cattle. After almost three years he had developed twin metabolism chambers for measuring total respiratory and nutritional balances. These devices operated almost continuously for the next 10 years, until the research was interrupted by World War II. The studies dealt with the influence of phosphorus deficiency on energy metabolism and the nutrient values of various feedstuffs. Kleiber also studied the respiratory metabolism of smaller animals, and from these he concluded that the metabolic rate was proportional to the ¾ power of body size. Credit for the metabolic body size rule was shared with Samuel Brody of Missouri, who independently published the same conclusion simultaneously. Kleiber also concluded from his studies that the efficiency of food utilization was an individual (genetic) characteristic that was independent of body size, a principal that has become known as Kleiber's Law (1).

After World War II, Dr. Kleiber became interested in the use of isotopic tracers in studying intermediate metabolism. In 1946 he spent a sabbatical at the Department of Biochemistry, University of Chicago, to become acquainted with the technology of isotopic tracers. On his return, and with the support from the U.S. Atomic Energy Commission, he organized a research program to study the intermediate metabolism of animal production, particularly milk formation. In this he had the collaboration of several graduate students, visiting scientists, and colleagues who called themselves the "Tracer Team." The research included studies of the kinetics of phosphorus and calcium metabolism, the precursors of lactose, and milk fat. He was able to establish transfer quotients for many feedstuffs, indicating their contribution to milk and tissue formation. Dr. Kleiber became Professor Emeritus in 1960; however, he remained active in science for another 15 years. In 1962 he published a book dealing with whole-animal energetics, *Fire of Life*, which is still useful 25 years later.

Dr. Kleiber was known and admired for his humanitarian principles as well as for his scientific stature. He was regularly an invited speaker at student seminars and scientific meetings. During his career he received many honors, including Faculty Research Lecturer (1945), the American Institute of Nutrition's Borden Award (1952), the University of Missouri's Brody Memorial Lecturer (1960), and at the Davis commencement of 1962 he received an LL.D. degree. In 1975, a major building on the Davis campus, Kleiber Hall, was dedicated. In 1982 the Max Kleiber Graduate Research Prize was established to recognize graduating M.S. or Ph.D. candidates for excellence/significance of their theses in the area of nutrition and metabolism.

(Biographies of H. H. Cole and Max Kleiber are

available from The Oral History Center, Shields Library, University of California, Davis, CA 95616.)

Frederick W. Lorenz [1908–] a native of Berkeley, earned a B.S. (Chemistry) at UCB in 1931; while still an undergraduate he joined the technical staff of the Division of Poultry Husbandry on the Berkeley campus. This position included independent research on the physicochemical properties of eggs. In 1935 he undertook graduate study with Dr. I. L. Chaikoff on endocrine factors in avian lipid metabolism, receiving the Ph.D. degree in 1938.

Dr. Lorenz joined the faculty of the Division of Poultry Husbandry on the Davis campus in 1938, where he continued his research on eggs and on lipid metabolism. Studies extending from his discovery of the stimulating influence of estrogen on growth and fat deposition in birds were continued while on leave in 1945–46 with White Laboratories, Inc., Newark, New Jersey. He also studied avian reproduction, particularly sperm production and metabolism. His discovery of the sperm storage site at the female's utero-vaginal junction was the basis for later studies of mechanisms responsible for the prolonged fertile period after insemination and of factors affecting embryo normality. Research in spermatology and fertilization was continued and further developed during sabbaticals at the California Institute of Technology (1950) with Professor Albert Tyler; at Cambridge University (1957–58) with Dr. Thadeus Mann; and at University College, London (1970–71) with Dr. Ruth Bellairs.

Dr. Lorenz organized a lecture and laboratory course in avian physiology, which is still being taught, and subsequently participated in developing and teaching comparative and systemic physiology courses of the Group and the Department of Animal Physiology. Dr. Lorenz had a key function in the organization of physiologists by virtue of his senior position and his ability to deal with department chairmen and deans, not all of whom were favorable to such a development. He was unanimously elected as spokesman for the campus physiologists.

Honors Dr. Lorenz received during his career include the Poultry Science Association's Research Prize (1945) and the Borden Award (1960). In 1974 he became Professor Emeritus but continued research in avian reproduction for several years and also developed interest in psychophysiology with special emphasis on biofeedback. He developed and taught a course in biofeedback, which is continuing, while conducting research on applications of various feedback techniques.

Post–World War II

After World War II the Davis campus grew in both student body and faculty. The numbers of physiologists on the campus increased substantially, and they were distributed among the various existing departments. Later physiologists were added to these and other newly organized departments, three of which were primarily concerned with physiology. In 1985, there were 63 active physiologists on the Davis campus, largely divided among seven departments. Several physiologists came to the Davis campus before there was any organization of physiology.

Perry T. Cupps [1916–] earned a Ph.D. degree in physiology at Cornell University in 1943. After service in the U.S. Navy as an aviation physiologist, he joined the faculty of the Animal Husbandry Department in 1946, where he was active in physiological teaching and research until his retirement in 1983. His areas of research were in endocrinology, particularly of the adrenal and thyroid.

Louis W. Holm [1917–] earned a Ph.D. degree in zoology from the University of Wisconsin in 1943. After service in the toxicity laboratory at the University of Chicago and on the faculties of Union College and the University of Wisconsin, he joined the faculty of the School of Veterinary Medicine in 1949, where he remained until retiring in 1965. His scientific interest included the physiology of pregnancy (placenta, fetus and neonate), endocrinology, and metabolic disease.

Wilbor O. Wilson [1910–] earned a Ph.D. degree in animal breeding at Iowa State University in 1947. After serving on the faculty of South Dakota State College (1937–44), he joined the faculty of the Poultry Husbandry Department in 1946. Although his advanced training was in genetics, his research and teaching were principally on the environmental physiology of domestic fowl. He retired in 1978.

Arthur H. Smith [1916–], after service as an aviation physiologist in the U.S. Navy, earned a Ph.D. degree (Comparative Physiology) at UCB in 1948. He joined the faculty of the Poultry Husbandry Department and engaged in studies of egg formation and the environmental physiology of domestic fowl. In 1964 he transferred to the Department of Animal Physiology, where he studied environmental physiology, particularly high altitude and gravitational physiology. In collaboration with C. F. Kelly, an agricultural engineer, and C. M. Winget, he developed a program of chronic acceleration research that indicated that gravity exerts a broad influence on physiological function. He became Professor Emeritus in 1986.

Arthur L. Black [1922–] earned a Ph.D. degree (Comparative Physiology) at the University of California, Davis (UCD) in 1951 after service with the U.S. Army Air Force in World War II. He joined the faculty of the School of Veterinary Medicine in 1951. His research centered on the use of isotopes in the study of gluconeogenesis and its control in ruminants and on biosyntheses and intermediate metabolism of amino acids. He served as Chairman of the Department of Physiological Sciences 1968–74.

James M. Boda [1924–] served with the surface forces of the U.S. Navy in the Pacific in World War II and then earned a Ph.D. degree (Comparative Physiology) from UCD in 1953. In 1952 he joined the faculty of the Department of Animal Husbandry. His research interests were in endocrinology and the physiological adaptation of animals to environmental extremes. He was particularly successful as a teacher and in 1970 was awarded the "Golden Apple" for teaching excellence by the student body. In 1968 Dr. Boda was transferred, as Chairman (1968–72), to the Department of Animal Physiology. After 1973 Boda became interested in desert pupfish, and his research became oriented toward physiological adaptation of aquatic animals until his retirement in 1983.

As the number of physiologists on the Davis campus grew, there was an increasing desire for some recogni-

tion according to discipline as well as improvement in offerings to support graduate instruction. This led to the formation of the Undergraduate Group in Animal Physiology.

First Organization of Physiology at Davis

For 10 years (1953–64) a faculty-organized group performed the functions of a department of physiology, developing and administering a curriculum leading to a B.S. degree in animal physiology as well as developing and offering physiology courses needed for the curriculum. Faculty participation and some minor support for courses were arranged at the departmental level.

This unusual enterprise had its origin in a meeting (June 1951) held by the physiologists of the campus to consider what steps could be taken to improve and coordinate instruction of physiology on the campus. Attending this meeting were H. H. Cole, P. T. Cupps, and Max Kleiber of the Department of Animal Husbandry; F. W. Lorenz and A. H. Smith of the Department of Poultry Husbandry; and S. A. Peoples of the School of Veterinary Medicine.

Further meetings were held with larger groups, including chairmen of the departments of the involved faculty, leading to the appointment of a committee by the Academic Senate (1952) to consider a group major in the discipline of physiology: H. H.Cole, L. W. Holm, and F. W. Lorenz (chairman). In April 1953 an undergraduate animal physiology major, in the curriculum of animal science, was approved by the faculty and staff organization of the College of Agriculture. The Group in Animal Physiology appointed to administer the major consisted of J. M. Boda, F. D. Carrol, H. H. Cole, P. T. Cupps, and Max Kleiber from the Department of Animal Husbandry; F. W. Lorenz (chairman), A. H. Smith, and W. O. Wilson from the Department of Poultry Husbandry; A. L. Black, G. H. Hart, L. W. Holm, D. E. Jasper, L. M. Julian, S. A. Peoples, and C. Stormont from the School of Veterinary Medicine; L. E. Rosenberg and G. W. Salt from the Department of Zoology; and C. F. Kelly from the Department of Agricultural Engineering.

The period of existence of the Undergraduate Group in Animal Physiology was a time of major growth of the Davis campus and of the establishment of new colleges and departments. Discussions on the establishment of a physiology department were frequent, with considerable disagreement among those concerned. Many were opposed to a physiology department because they felt it would remove physiologists from existing departments, particularly those related to production agriculture. However, all regarded the undergraduate group favorably—some favored it because it obviated the need for a department, whereas others favored it as an intermediate step in establishing a department.

The group offered a graduate physiology seminar, lecture and laboratory courses in general physiology, and courses in comparative physiology. The program was immediately successful. In 1954, after one year of operation, two students graduated with B.S. degrees in animal physiology and an additional four were enrolled in the program. Over the 10-year period of the Undergraduate Group, 20 B.S. degrees in animal physiology were awarded.

Department of Physiological Sciences

In 1944, the Davis campus was selected as the site for the School of Veterinary Medicine, and in 1946 the Regents of the University of California authorized the granting of the D.V.M. degree. Dr. C. M. Haring (Department of Veterinary Sciences, UCB) was appointed dean in 1947 and on his retirement in 1948 Dr. George H. Hart succeeded him. When the school was departmentalized in 1960, the Department of Physiological Sciences was established under the chairmanship of S. A. Peoples. L. W. Holm and A. L. Black were also members of the original Department, which offered instruction in pharmacology, physiology, and physiological chemistry. In 1983 the pharmacologists left the Department to form a new Department of Pharmacology and Toxicology.

S. Anderson Peoples [1908–] earned an A.B. degree (Chemistry) from UCB (1930) and the M.D. degree from University of California, San Francisco (UCSF) (1934). He was on the faculty of the medical schools at the Universities of Louisville (1936–38), Alabama (1938–43), and Baylor at Houston (1943–47) before coming to the Davis campus in 1947. His research interests involved the toxicology of pesticides in animals. He became Professor Emeritus in 1976.

Richard A. Freedland [1931–] joined the Department in 1960, after completion of his Ph.D. (1958) and postdoctoral studies at the University of Wisconsin. His major research interest concerned nutritional and hormonal effects on enzyme activities and control of metabolic flow utilizing perfused liver and isolated hepatocytes. He became Chairman of the Department in 1974.

Harold R. Parker [1920–], after service in the U.S. Army Air Force, received his D.V.M. degree (1952) and Ph.D. (1961) from UCD. He taught the mammalian physiology course in the Department of Physiological Sciences until 1977, when he transferred to the Department of Surgery. His research interests have involved neonatal physiology and the pathophysiology of the kidney.

Charles E. Cornelius [1927–] received his D.V.M. in 1953 and Ph.D. in 1958 at UCD and joined the faculty of Veterinary Medicine in 1958. He participated in teaching courses in the Group in Animal Physiology and in the Veterinary curriculum. After one year as departmental chairman (1965) he left to become Dean of the Colleges of Veterinary Medicine at Kansas State (1966–71) and at the University of Florida (1971–81). In 1981, he returned to Davis as Director of the California Primate Research Center and Professor of Physiological Sciences. He was named Florida's Veterinarian of the Year in 1979 and received the UCD Alumni Achievement Award in 1981. In 1982, the University of Florida awarded him a D.Sc. (honoris causa) and in 1984 the University of Pennsylvania bestowed the Centennial Medal on him. His research has dealt with hepatic transport of bile pigments and mechanisms responsible for jaundice in animals and man.

Victor W. Burns [1925–], after service in the U.S. Army Air Force, earned a Ph.D. (Biophysics) at UCB in 1955. After a period at Stanford University, he joined

the faculty of Physiological Sciences at Davis in 1972. His research on cell biophysics and cell division has led to division synchronization techniques and cellular microviscosity measurements.

Jerry R. Gillespie [1937–] received the D.V.M. degree from Oklahoma State University in 1961 and his Ph.D. (Comparative Pathology) from UCD in 1965. After one year as a Postdoctoral Fellow at the Cardiovascular Research Institute, UCSF, he joined the clinical faculty in the Veterinary School in 1966 and transferred to the Department of Physiological Sciences in 1971. He moved to Kansas State University in 1985. His research is principally comparative respiratory physiology.

Quinton R. Rogers [1936–] studied with Alfred E. Harper at the University of Wisconsin, receiving a Ph.D. (Biochemistry) in 1963. He was on the faculty of Nutrition and Food Science at the Massachusetts Institute of Technology until 1966 when he joined the faculty of Physiological Sciences at Davis. His principal interests have been in amino acid nutrition and metabolism, particularly the role of dietary amino acids in the neurocontrol of food intake.

Robert E. Smith [1913–1979] received a Ph.D. (Physiology) from UCB in 1946. His graduate studies were interrupted by service in the U.S. Navy (1942–48), which included participation in the radiological survey of Hiroshima and Nagasaki and in the Bikini nuclear tests. After serving as Principal Physiologist at the National Institutes of Health (1948–51) he joined the Physiology faculty of the University of California, Los Angeles (UCLA) Medical School. In 1967, he transferred to the faculty of Physiological Sciences at Davis, serving one year as chairman. His early research dealt with the diffusion of inert gases in body tissues and their role in decompression sickness. Later he became interested in cellular mechanisms in energy metabolism, finding that mitochondrial concentrations were closely related to body size. He also identified brown fat as a principal thermogenic effector. He became Professor Emeritus in 1972.

Alfred A. Heusner [1931–], a native of France, completed his education at the University of Strasbourg, receiving his Ph.D. degree in 1963. He was in charge of research at the Physiological Institute in Strasbourg from 1963 to 1967, when he joined the faculty of Physiological Sciences at Davis. He was awarded the "Prix Naturalia et Biologica" in 1966 from the College de France. His research has dealt with biorhythms and comparative studies of bioenergetics.

Robert J. Hansen [1937–] completed his Ph.D. (Physiology) at the University of Chicago in 1969. He joined the faculty of Physiological Sciences at Davis in 1968. His research interests are the hormonal and nutritional control of the turnover of specific proteins in liver, muscle, and adipose tissue.

Donald L. Curry [1936–] earned the Ph.D. (Physiology) at UCSF in 1967. Dr. Curry joined the faculty of Physiological Sciences in 1969, where he investigates factors regulating or modifying insulin secretory dynamics and insulinogenesis.

Douglas G. Stuart [1931–], a native of Australia, received the Ph.D. (Physiology) from UCLA in 1961. He was a research fellow (1961–63) and Assistant Professor of Physiology (1963–65) at UCLA before coming to Davis in 1965. In 1967 he moved to the University of Arizona, College of Medicine. His research interests have involved neural control of posture and locomotion and the influence of weightlessness on these functions.

David S. Kronfeld [1928–], a native of New Zealand, received a Ph.D. degree in physiology (1960) from UCD and a D.Sc. (Biochemistry, 1972) from the University of Queensland. He was on the faculty of Physiological Sciences from 1960 to 1967 and then transferred to the Veterinary School at the University of Pennsylvania. His research has involved metabolic diseases and kinetic analysis of metabolic processes.

Michael L. Bruss [1945–] received a D.V.M. (1969) from Colorado State University and a Ph.D. (Physiology) from UCD in 1974. After a postdoctoral fellowship (1974–75) in Veterinary Medicine at Vienna, he joined the faculty in Physiological Sciences at the University of Florida (1975–80). He transferred to the faculty in Physiological Sciences at Davis in 1981. His research interests have included metabolic disorders in large animals and the role of nutrition in exercise, growth, pregnancy, and lactation.

James H. Jones [1952–] received a Ph.D. (Comparative Physiology) from Duke University in 1979 and a D.V.M. from Colorado State University in 1983. Before joining the faculty in Physiological Sciences at Davis (1986), he was a fellow at Capetown University, Union of South Africa (1980) and a Lecturer in Biology at Harvard University (1983–86). His research deals with the comparative physiology of respiration and exercise physiology.

Other faculty in the Veterinary School also have participated in the physiology program. Edward A. Rhode, Jr. [1926–] received the D.V.M. from Cornell (1947) and served on the Veterinary Medicine faculty at Kansas State (1947–51) before joining the School of Veterinary Medicine at Davis (1951). He was Associate Dean, Instruction (1971–82) and Dean, School of Veterinary Medicine (1982–). His research interests include comparative mammalian cardiovascular physiology, veterinary cardiology, and clinical medicine; he has taught comparative cardiovascular physiology throughout his tenure.

J. Jerry Kaneko [1924–], after military service, attended UCD, where he earned the D.V.M. degree in 1956 and the Ph.D. in 1959 under Max Kleiber. His studies included research on amino acid metabolism. He joined the faculty of the School of Veterinary Medicine in 1957 and served as Chair of the Department of Clinical Pathology (1969–85). He participated in teaching courses in the Undergraduate Group in Animal Physiology and the veterinary curriculum. His major areas of interest are metabolic physiology, biochemistry, and nutrition, with emphasis on the hemolymphatic system.

George H. Stabenfeldt [1930–] received a D.V.M. degree from Washington State University in 1956 and a Ph.D. (Physiology) from Oklahoma State University in 1968. He was on the Physiology faculty at Oklahoma State (1962–68) before joining the clinical faculty in reproduction in the School of Veterinary Medicine at Davis (1968). His research interest is the reproductive physiology of female domestic animals.

Eugene P. Steffey [1942–] received a V.M.D. from the University of Pennsylvania in 1967 and a Ph.D. (Physiology) from UCD in 1973. After a postdoctoral

fellowship in anesthesiology at UCSF he joined the surgery faculty of the School of Veterinary Medicine at Davis in 1974. His research interest is the influence of anesthesia on circulatory and respiratory function.

Department of Animal Physiology

Although the Undergraduate Group in Animal Physiology continued to function as an academic unit, progress was impeded by the lack of a specific budget and by faculty titles that lacked physiology identity. In 1960 a subcommittee was appointed "to prepare a comprehensive report on the present status and future development of physiology on the Davis Campus": J. M. Boda, C. E. Cornelius, L. W. Holm, C. F. Kelly, and A. H. Smith (chairman). As generally expected, the report included a recommendation for the establishment of a department, and in March 1960, a formal request for a Department of Animal Physiology made to Chancellor E. M. Mrak via the Dean of the College of Agriculture, F. N. Briggs. However, another three years elapsed until the establishment of the Department on January 1, 1964.

Initially the Department of Animal Physiology consisted of faculty drawn from other units on the campus: F. W. Lorenz (who served as chair from 1964 to 1968), A. H. Smith, W. E. Howard, a vertebrate ecologist, and one unfilled appointment. J. M. Boda was transferred to the Department, as Chairman, from 1968 to 1973. An additional three physiologists were recruited from other universities, expanding the teaching program of the department as well as extending the scope of its research activities in all fields of physiology. Harry W. Colvin [1921–], after service in the U.S. Third Army in World War II, earned a Ph.D. (Comparative Physiology) from UCD in 1957. After serving on the faculties of Oklahoma State University (1956–57) and University of Arkansas (1957–65) he returned to Davis in 1965 as a member of the Animal Physiology faculty. In addition to teaching courses in general, mammalian, and gastrointestinal physiology, Dr. Colvin was particularly active and effective in undergraduate advising. His research interests are gastrointestinal physiology, principally ruminants, and factors affecting hemostasis.

Irving H. Wagman [1916–1977] received a Ph.D. degree (Physiology) from UCB in 1941. In World War II he did research with the U.S. Navy on cold-protective clothing and night vision, including development of design principles for night vision binoculars. He joined the faculty of the Jefferson Medical School in 1946 but left in 1953 because of moral disagreement with a loyalty oath. He joined the staff of Mount Sinai Hospital in New York City as a research neurologist, leaving in 1961 to join the staff of the Biomechanics Laboratory of UCSF. This laboratory was engaged in research on prosthetic devices for amputees; Wagman's area of research was in somatosensory physiology. In 1965, he transferred to the faculty of Animal Physiology at Davis, with a joint appointment in the California Primate Research Center. He organized a core of undergraduate and graduate courses in neurophysiology that continued after his untimely death. His research interests included the physiology of vision, the electrical characteristics of peripheral nerves, neurological basis of posture, integration of cutaneous input, and neural mechanisms associated with noxious stimuli.

Dorothy E. Woolley [1929–] received a Ph.D. degree (Physiology) from UCB in 1961 and joined the Department of Animal Physiology in 1965. She was departmental chair from 1978 to 1983. Her research interests are neurophysiology, especially the effects of hormones, drugs, and neurotoxins on electrical activity of the brain, and neuroendocrinology.

The Department of Animal Physiology soon became the principal undergraduate teaching department in physiology on the Davis campus, offering programs leading to the B.S. degree in physiology in both the Colleges of Agriculture and Environmental Science and of Letters and Sciences. [The existence of multiple physiology departments on the same campus required that they have distinctive names. However, all courses offered by the Animal Physiology Department and all academic degrees (B.S., M.S., and Ph.D.) are designated as "physiology."] In response to its increasing teaching commitment, the Animal Physiology faculty underwent a rapid growth with the appointment of several additional physiologists with diverse research interests. John M. Horowitz [1934–] received his advanced training at UCB, earning the B.S. (Electrical Engineering) in 1959, M.S. (Electrical Engineering) in 1961, and Ph.D. (Biophysics) in 1968. In 1968 he joined the faculty of Animal Physiology and became its Chairman in 1983. His area of research interest is neurophysiology, particularly the neural aspects of thermoregulation and the neurology of the hippocampus.

Barbara A. Horwitz [1940–] completed the Ph.D. (Physiology) at Emory University in 1966. After postdoctoral study in the Department of Physiology, Medical School at UCLA and in the Department of Physiological Sciences, UCD, she joined the Animal Physiology faculty in 1972. Her research interests are in general physiology, particularly thermogenesis in brown fat.

Verne E. Mendel [1923–], after World War II service in the U.S. Army in the Aleutians, received the Ph.D. degree (Comparative Physiology) from UCD in 1960. After service on the Physiology faculty of the University of Alberta (1960–63), he joined the faculty of the Department of Animal Science at Davis in 1963. He transferred to Animal Physiology in 1973, serving a term (1973–78) as its chairman. His research interests are environmental physiology, gastrointestinal endocrinology, and the regulation of food intake.

Jack M. Goldberg [1942–] earned a Ph.D. (Physiology) at Loyola University in 1974 and joined the Animal Physiology faculty in 1973. His research interests relate to the electrophysiology of the heart and the autonomic control of heart and vasculature.

Arnold J. Sillman [1940–] received a Ph.D. (Zoology) from UCLA in 1968. After faculty service at UCLA and the University of Pittsburgh (1973–75) he joined the Animal Physiology Department in 1975. His area of research interest is the physiology and biochemistry of the vertebrate retina. With others, he demonstrated that the primary effect of light in eliciting the visual response was the decrease in permeability of the photoreceptor membrane to sodium ions.

W. Jeffrey Weidner [1947–] received a Ph.D. (Physiology) from Michigan State University in 1973. After

a postdoctoral fellowship at the Cardiovascular Research Institute, UCSF, he joined the faculty of Animal Physiology in 1975. His research interests are cardiopulmonary physiology and circulatory shock.

After 1975, the Department's growth slowed, and a steady state was reached. New members arrived at a Department with established traditions, an emphasis on research in diverse areas of physiology, and a continued emphasis on teaching programs at the graduate and undergraduate levels. Marylynn S. Barkley [1943–] received a Ph.D. (Reproductive Endocrinology) from the University of Connecticut in 1975. After a period as research scientist, collaborating with I. I. Geschwind in Animal Science (1974–78), she joined the faculty of Animal Physiology. Dr. Barkley's research interests are in reproductive endocrinology, including the hormonal control of gestation and the nature of estrogenic stimulation in females.

Earl E. Carstens [1950–] received a Ph.D. (Physiology) at the University of North Carolina in 1977. After a postdoctoral period at the University of Heidelberg (1977–80) he joined the Department of Animal Physiology. His research area is neurophysiology, particularly the control of spinal cord transmission of nociceptive signals.

Pamela Pappone [1950–] earned the Ph.D. (Physiology/Biophysics) from the University of Washington in 1978. After a postdoctoral fellowship in the Department of Physiology-Biophysics at the University of California, Irvine, she joined the faculty in Animal Physiology in 1982. Her research interests are in neurophysiology, particularly regarding factors influencing the behavior of ionic channels in excitable cells and the role of cell membrane composition and structure.

Charles A. Fuller [1949–] received a Ph.D. (Physiology) at UCD in 1975. After a postdoctoral period at Harvard Medical School (1975–79) he joined the Division of Biomedical Sciences at the University of California, Riverside. In 1984 he transferred to the Animal Physiology Department at Davis. His area of research interest includes neurophysiology, physiological control systems (sleep, temperature regulation, and rhythms) and environmental physiology, particularly gravitational physiology. He has been an investigator on three projects on the space shuttle dealing with the influence of weightlessness on homeostasis.

Other faculty of the College of Agriculture and Environmental Sciences also contribute to the Physiology Program: Charles L. Judson [1926–], after service in the U.S. Navy in World War II, received a Ph.D. degree (Entomology) from UCB in 1956 and joined the faculty of Entomology at Davis, where he offers both upper division and graduate courses in insect physiology. These are particularly useful to students interested in comparative physiology. His research interests are insect biochemistry and physiology particularly reproduction and digestion.

Joseph J. Cech, Jr. [1943–] received a Ph.D. (Zoology) from the University of Texas in 1973 and joined the Wildlife and Fisheries Biology faculty at Davis in 1975. He teaches a course in the physiology of fish and participates in the departmental course on comparative physiology of respiration. His research interests are in the environmental physiology of fish, particularly regarding respiration, circulation, and hematological response. In collaboration with others, he found a reverse thermal effect on the O_2-dissociation curve of tuna hemoglobin over the range of core temperature control.

Charles M. Winget [1925–], after service in the U.S. Navy in the Pacific, received a Ph.D. (Comparative Physiology) from UCD in 1957. After an NIH postdoctoral fellowship studying labyrinthine sensitivity and the influence of chronic acceleration on it, and after service on faculty of the University of Guelph, he became a research scientist at the Ames Research Center (National Aeronautics and Space Administration). Since 1977 he has offered a graduate physiology course on biorhythmicity on the Davis campus.

After 35 years of development, starting with the organization of the Undergraduate Group in Animal Physiology in 1952, physiology has become one of the principal undergraduate curricula at Davis. The number of students majoring in physiology is large, averaging 367 over the period 1981–85; in 1985, 141 students received B.S. degrees in physiology. The Department offers a substantial selection of courses to these students, including 5 courses in general physiology, 10 courses in systemic physiology, 5 courses in comparative physiology, and 3 courses in environmental physiology. In the period 1972–85 the number of students enrolled in departmental courses has averaged 3,700 annually.

The Department also offers graduate courses, as part of the cooperative graduate training effort in which all physiologists on the campus participate, and provides an administrative base for the Graduate Group in Physiology.

Department of Animal Science

The Department of Animal Science had its origin on the Berkeley campus in 1901, when the state legislature appropriated $10,000 for instruction in dairying, which included the construction of a laboratory and barn and the acquisition of a small dairy herd. In 1908–09 this animal industries unit was moved to the Davis campus and, after 1917, designated the Division of Animal Husbandry. In 1929 physiology was added, with the appointments of Harold H. Cole and Max Kleiber. After World War II the increasing importance of physiology to both teaching and research led to the appointments of Perry T. Cupps (1946) and James M. Boda (1952). Verne E. Mendel was on the faculty of Animal Science from 1963 to 1973, when he transferred to the Department of Animal Physiology. As the breadth of research and instruction in the department increased, particularly regarding reproductive endocrinology, prenatal and postnatal growth, and the development of muscle, there were further appointments of physiologists to the departmental faculty.

M. Tran Clegg [1918–] served in the Hospital Corps of the U.S. Navy during World War II and then earned the Ph.D. degree (Comparative Physiology) at UCD in 1953, when he joined the faculty of the Department of Animal Husbandry. He participated in teaching general physiology in the Group in Animal Physiology and endocrinology in the Animal Science curriculum. In 1968 he went to Tulane University, where he engaged in research at the Delta Regional Primate Center. His

research continued to be in the area of endocrinology of growth and reproduction.

Irving I. Geschwind [1923–1978] earned the Ph.D. degree (Endocrinology) at UCB in 1949. He joined the staff of the Hormone Research Laboratory on the Berkeley campus, where he was involved in the isolation and purification of the melanocyte-stimulating hormone and the determination of its amino acid sequence. In 1960 he joined the faculty of Animal Science at Davis, where he continued his research on melanocyte-stimulating hormone until his untimely death. He served as Editor-in-Chief of the *Journal of Endocrinology* (1973–77) and on the National Research Council Board of Biochemical Nomenclature. In 1980 the annual Geschwind Memorial Lectureship was established at Davis.

Ransom L. Baldwin [1935–] received his Ph.D. (Biochemistry) at Michigan State University in 1962 and joined the Animal Science Department at Davis in 1962. His research interests are in the microbiology, biochemistry, and physiology of digestion and metabolism in ruminants, physiology of lactation, and the application of modeling techniques in animal metabolism.

C. Robert Ashmore [1934–] earned a Ph.D. (Developmental Biology) at the University of Connecticut in 1968 and joined the faculty of Animal Science in July 1968. His research interests are skeletal muscle growth and development and muscle diseases.

J. Warren Evans [1938–] received his Ph.D. (Physiology) at UCD in 1968 and then joined the faculty of Animal Science. In 1985 he left to join the faculty of Animal Science at Texas A & M University. His research areas are environmental physiology, particularly gravitational physiology, biological rhythms, lipid metabolism, and equine reproduction and nutrition.

Gary P. Moberg [1941–] received his Ph.D. (Physiology) from the University of Illinois in 1968. After a postdoctoral fellowship in neuroendocrinology at UCSF, he joined the faculty of Animal Science in 1970. He was a guest scientist with NASA (1970–75) and has been affiliated with the California Primate Research Center since 1979. His research interests are in neuroendocrinology with emphasis on the endocrine response to stress.

Gary B. Anderson [1947–] received a Ph.D. (Vertebrate Physiology) from Cornell University in 1973 and joined the faculty of Animal Science in 1974. His area of research is the physiology of early embryonic development.

Thomas E. Adams [1947–] received his Ph.D. (Physiology and Biophysics) from Colorado State University in 1979. After a postdoctoral fellowship at the Oregon Regional Primate Research Center, he joined the faculty of Animal Science in 1981. His area of research interest is the endocrinology of reproduction, with particular emphasis on hypothalamic control of gonadotrophin function.

Yu-Bang Lee [1942–], a native of Korea, received a Ph.D. (Muscle Biology and Biochemistry) from the University of Wisconsin in 1972. After a period as senior research scientist at the Campbell Institute for Food Research and the Korea Institute of Science and Technology, he joined the Department of Animal Science in 1981. His research interests are growth and development of muscle and adipose tissue and postmortem biochemistry of muscle.

Patricia J. Berger [1953–] received a Ph.D. (Animal Sciences) from Purdue University in 1980. After a period as a research scientist in the Department of Obstetrics and Gynecology at the University of Southern California, she joined the faculty in Animal Science in 1983. Her research interests are mammalian fertilization and very early embryonic development.

Department of Avian Sciences

The precursor of the Department of Avian Sciences was an experiment station that operated from 1904 to 1909 on a poultry farm near Petaluma, directed by a committee of the Agriculture Faculty at Berkeley. In 1909, three courses of poultry husbandry were added to the Davis curriculum, and in 1910 a resident instructor was appointed to teach them. In 1933, V. S. Asmundson [1895–1974], a geneticist, joined the faculty of Poultry Husbandry and initiated research on egg production and turkey breeding. A biochemist, Thomas H. Jukes [1906–], was appointed to the faculty in 1935, investigating growth factors (vitamins). The first physiologist, F. W. Lorenz, joined the faculty in 1938, followed by W. O. Wilson in 1946 and A. H. Smith in 1950. In 1964, Lorenz and Smith were transferred to the newly formed Department of Animal Physiology.

Up until 1951, the chairman of Poultry Husbandry was located in Berkeley. In 1951, the chairmanship was transferred to Davis with the appointment of G. F. Stewart [1908–1980], a food technologist. Subsequently the departmental scope and the faculty were considerably enlarged, and the Department was renamed Avian Sciences in 1966. Instruction and research in physiology were also increased with the appointment of additional physiologists.

Ursula K. Abbott [1927–] received a Ph.D. (Genetics) from UCB in 1955 and then joined the Department of Poultry Husbandry at Davis. She served as Chair of Avian Sciences from 1981 to 1984. She teaches courses on developmental biology and also has contributed to a graduate course on neuroendocrinology. Her research interests include gene expression and modification, teratology, and development. She has collaborated in studies of environmental influence (chronic acceleration, hypoxia) on embryonic development.

Frank X. Ogasawara [1913–], after receiving a Ph.D. (Comparative Physiology) from UCD in 1957, joined the Poultry Husbandry Department. He taught avian physiology and participated in a graduate course in neuroendocrinology. His research interests included the physiology of reproduction, especially the male gamete, and their storage in the female. He became Professor Emeritus in 1984.

Barry W. Wilson [1931–] received a Ph.D. (Zoology) from UCLA in 1962 and joined the Poultry Husbandry Department in 1963, with joint appointments in Physical Medicine and Rehabilitation and in Environmental Toxicology. His research interests include the development and interactions between nerve and muscle, especially those involving acetylcholinesterase, muscular dystrophy, neurotoxicity, and pharmacology.

Ray E. Burger [1927–] received a B.S. (Chemistry) and Ph.D. (Endocrinology) in 1958 at UCB. After

faculty service at the University of Minnesota (1958–63) and Special Training Fellowship (NIH) at the Biomechanics Laboratory, UCSF (1963–64), he joined the Poultry Husbandry Department at Davis, with a joint appointment in the Department of Animal Physiology. He teaches advanced mammalian physiology laboratory and avian physiology, lecture, and laboratory. He and Irving Wagman developed a system of audiovisual carrels for mammalian physiology laboratory instruction (1966), which greatly enhanced the success of student experiments. His research interest is the control of ventilation in birds, with emphasis on intrapulmonary CO_2 chemoreceptors.

Wesley W. Weathers [1942–] received a Ph.D. (Zoology) at UCLA in 1969. He was on the faculty of Environmental Physiology at Rutgers University (1970–75) before joining the Avian Sciences Department at Davis in 1975. He has taught undergraduate courses in animal physiology, environmental physiology, and physiological ecology. His earlier research interests included comparative cardiovascular physiology and circulatory and metabolic responses to hypoxia; his later interests include thermoregulation, metabolic adaptation to climate, and the energetics and biophysics of thermal relations in free-living birds.

James R. Millam [1949–] received a Ph.D. (Animal Physiology) from the University of Minnesota in 1981 and joined the faculty of Avian Sciences in 1982. He teaches environmental physiology and a graduate course, avian endocrinology. His research interests are environmental physiology, neuroendocrinology, and animal behavior.

Department of Zoology

Zoology on the Davis campus started with the appointment of Tracy I. Storer [1889–1973] to the faculty in 1923. When the curricula were reorganized in 1926, courses in anatomy and embryology were added to the animal husbandry major, which were offered by the newly established Division of Zoology. This became the Department of Zoology in 1952 when the College of Letters and Sciences was formed.

In addition to offerings in zoology, the Department is engaged in instruction in physiology. At the graduate and upper-division level it offers courses in neurophysiology, invertebrate physiology, muscle and membrane. It also offers lower-division courses in systemic physiology. This commitment to physiological instruction led to the appointment of several physiologists to the Zoology faculty.

Ronald J. Baskin [1935–] received a Ph.D. (Biophysics) from UCLA in 1960. After a postdoctoral fellowship at the National Heart Institute and faculty service at Rensselaer Polytechnic Institute, he joined the faculty of Zoology at Davis in 1964. His research interests are in biophysics, particularly the structure and function of sarcoplasmic reticulum membranes and of the molecular mechanism of muscle contraction.

David W. Deamer [1939–] received a Ph.D. (Biochemistry) in 1965 from Ohio State University. After a postdoctoral fellowship at UCB, Professor Deamer joined the faculty of Zoology at Davis in 1967. His research interests are in cell membrane structure and function, enzymatic synthesis of phospholipids, mechanisms of proton transport across membranes.

John H. Crowe [1943–] received a Ph.D. (Biology) in 1970 from the University of California, Riverside, and then joined the faculty of Zoology at Davis. His research interests are invertebrate physiology and biochemistry and cell biology, with particular emphasis on cellular dehydration and freezing and intracellular water and its role in maintenance of macromolecular structure and membrane integrity.

Brian Mulloney [1942–] received a Ph.D. (Zoology) in 1969 from UCB. Prior to joining the faculty of Zoology at Davis (1974), he was a Research Associate at Stanford University, a Postdoctoral Fellow at Oxford University, and Acting Assistant Professor of Biology at the University of California, San Diego. His research interests are neurobiology and the neural basis of behavior. He is currently studying the synaptic organization of motor systems, integration of synaptic currents, quantitative neuroanatomy, and generation of motor patterns.

Richard L. Nuccitelli [1948–] received a Ph.D. (Biology) from Purdue University in 1975 and joined the faculty of Zoology at Davis in 1978. His research interests are in cell biology, cell physiology, and developmental biology, with an emphasis on the plasma membrane's role in cellular functions and particular interest in ooplasmic segregation and pattern formation.

Martin Wilson [1949–], a native of England, received a Ph.D. (Neurobiology) from Cambridge University in 1973. Prior to joining the faculty of Zoology at Davis (1981), he was Research Assistant and Research Fellow at the Australian National University and a Research Engineer at UCB. His research interests are in neurobiology and sensory physiology, and he currently studies information processing in the retina.

James S. Clegg [1933–] received a Ph.D. (Biology/Chemistry) in 1961 from The Johns Hopkins University. In 1962 he joined the faculty of Biology at the University of Miami, leaving in 1986 to join the Department of Zoology at Davis as the Director of the Bodega Marine Laboratory. His research interests are the biochemistry and biophysics of intact animal cells, particularly the properties and activities of their aqueous compartments, and comparative biochemistry.

Human Performance Laboratory

In 1962 a Human Performance laboratory was established in the Department of Physical Education, College of Letters and Sciences, for the study of the physiology of exercise, and it is used for both teaching and research. It provides the principal teaching and research resource on human physiology for the campus. It offers six undergraduate courses and one graduate course on exercise physiology and related subjects, which are available to undergraduate and graduate physiology students.

A major activity of the laboratory has been a study of the interaction of gravity, altitude, training, and physical performance, carried out by E. M. Bernauer and W. C. Adams, partly in collaboration with D. B. Dill [1891–1986] of the University of Nevada, Las

Vegas. Studies have been carried out on well conditioned athletes (runners) in hypobaric chambers and at high altitude at the White Mountain Research Center. Performance decrements at altitude and sea-level performance of runners that trained at high altitude were examined. It was concluded that training at high altitude did not enhance sea-level performance.

Edmund M. Bernauer [1926–] completed the Ph.D. degree (Physiology) at the University of Illinois in 1962, after service in the surface forces of the U.S. Navy in World War II. He joined the Physical Education faculty at Davis in 1962. His research interests include the physiology of exercise and body fluid regulation, the physiology of chronic recumbency, and the influence of high altitude on physical performance.

William C. Adams [1938–], after service in the U.S. Army (CIC) completed a Ph.D. (Physical Education/ Exercise Physiology) at the University of Illinois in 1964. He joined the faculty of Physical Education at Davis in 1965, where his research has dealt with the influence of heat, altitude, and photochemical air pollution on cardioresponse to prolonged exercise.

Paul A. Molé [1938–] completed a Ph.D. (Physiology) at the University of Illinois in 1969. After service on the faculties of Temple University (1971–74) and the Louisiana State University Medical Center (1974–77), he joined the faculty of Physical Education at Davis in 1977. His area of interest includes metabolic aspects of exercise, the adaptive effects of exercise, and the influence of exercise on human growth and development. He has developed methods to evaluate metabolic capacity of mitochondria, demonstrating that endurance training increases their fatty acid oxidation potential.

Rudolph H. Dressendorfer [1943–] received a Ph.D. (Physiology) from the University of Hawaii in 1974. He was on the staff of the Human Performance Laboratory at Davis, from 1976 to 1980, when he left to join the Division of Cardiovascular Diseases, William Beaumont Hospital, of the University of Michigan. His research interests are in hyperbaric physiology and physiological function in exceptionally well-trained athletes.

Robert G. Holly [1944–], after service in the nuclear power program of the U.S. Navy, serving on the nuclear submarine Barb, SSN 596 (1967–70), received a Ph.D. (Physiology) at UCD in 1979. He joined the Physical Education faculty at Davis in 1981, with responsibility for the adult fitness and cardiopulmonary rehabilitation programs. His research interests include the influence of passive stretch on growth and development of skeletal muscle and the effect of exercise on physical performance.

Department of Human Physiology

The Department of Human Physiology was founded in 1966 as part of the newly established Medical School. Its first chairman, Loren D. Carlson, was one of the seven founding members of the new school and also chairman of its Division of Sciences Basic to Medicine. The first faculty of the Department was recruited in 1967 and at the same time, several members of the clinical faculty were given joint appointments: Dean Mason, Robert Zelis, and James Spann (cardiology); Carroll Cross (pulmonary medicine); and Richard Walters (medical education). Joint appointments also included faculty of other schools: Jerry Gillespie (veterinary medicine), Irving Geschwind (animal science), and Irving Wagman (animal physiology). Dr. Carlson died in 1972 after a two-year illness, and Arnold Hsieh served as acting chairman until 1974, when Eugene M. Renkin, the present chairman, was appointed. The Department moved into permanent quarters in 1977 and in 1986 had a faculty of 11.

Loren D. Carlson [1915–1972] received a Ph.D. (Zoology) from the University of Iowa in 1941. During World War II, he served in the U.S. Army Air Corps Aeromedical Laboratory, Wright Field, Ohio, where his work on the design and testing of oxygen equipment led to the establishment of criteria for delivery of oxygen at various altitudes. In 1946, he joined the faculty of the Department of Zoology at the University of Washington, and with the formation of the Medical School he joined the Department of Physiology and Biophysics the next year. In 1960, he left to become Chairman of the Department of Physiology and Biophysics of the newly established College of Medicine at the University of Kentucky, Lexington. In 1966, he moved to Davis, where he remained as Assistant Dean and Chairman of the Division of Basic Medical Sciences and Chairman of the Department of Human Physiology until his death.

Dr. Carlson's main research interests were in environmental physiology, respiratory and circulatory function, metabolism and adaptation to cold, ionizing radiation, and gravitational changes. He is author and coauthor of 134 papers, review articles, and chapters. Dr. Carlson's interest in aerospace and environmental physiology led to his appointment as a consultant to various offices of the President, NASA, and the National Academy of Science. He served as President of the American Physiological Society (1968–69) and the Federation of American Societies for Experimental Biology (1969–70). He was the recipient of numerous awards, among them the Legion of Merit (1946) and the Decoration for Exceptional Civilian Service (1970) from the U.S. Air Force, the John Jeffries Award (1968) of the American Institute of Aeronautics and Astronautics, and the Air Force Office of Aerospace Research Outstanding Achievement Award (1962). St. Ambrose College conferred its Award of Merit to him in 1967, and in 1969 the University of Oslo, Norway, awarded him a Ph.D., honoris causa. In 1973, The Loren D. Carlson Award was established, to be given to the graduating Ph.D. with most "promise of excellence in research and teaching." In 1985 the campus biology and medicine library was renamed the Loren D. Carlson Health Science Library.

Initially the Department of Human Physiology was enlarged by the appointment of four additional physiologists, in preparation for its teaching obligations. Thomas C. Lee [1938–] received a Ph.D. in endocrinology from UCSF (1966). After a postdoctoral fellowship in the Department of Pharmacology, University of Utrecht, The Netherlands, he joined the faculty of Human Physiology in 1968. Dr. Lee's research interests center around the endocrinology of body fluids. In 1976 he left to joint the Hypertension Research Division of the Cedars-Sinai Medical Center in Los Angeles.

Lawrence Rabinowitz [1933–] earned a Ph.D. (Physiology) from UCB in 1961. After a period (1961–64) at the Laboratory of Kidney and Electrolyte Metabolism, National Heart Institute, NIH, he went to the Mt. Desert Island Biological Laboratory in Maine. After service on the Physiology faculty at the University of North Carolina School of Medicine (1963–67) he came to Davis. His research interests are in the field of renal physiology, water and solute excretion, and control of potassium excretion.

Robert E. Smith [1929–] earned his B.S. (Engineering) in 1951 from California Institute of Technology, becoming a practicing civil engineer (1951–54) and later serving in the U.S. Army (ASA). He received a Ph.D. (Physiology and Biophysics) from the University of Washington in 1962. After service on the Physiology faculty at the University of Kentucky (1962–67), he joined the Department of Human Physiology (1967). His research is concerned with physiological control systems, physiological models, and biological oscillations.

Arnold C. L. Hsieh [1922–] received an M.D. degree from St. John's University, Shanghai, in 1946, and joined the Department of Physiology at the University of Hong kong (1953–68). During this period he was a visiting scholar at the University at Washington (1956–57) and the University of Kentucky (1963). He was awarded a D.Sc. (Physiology) by Hong Kong University in 1965. In 1968, he transferred to the Department of Human Physiology, Davis, returning to Hong Kong in 1976 to assume the Chair of Physiology. Dr. Hsieh's research interests are in the field of metabolism and temperature regulation. He coauthored with Dr. Carlson an important monograph, *Control of Energy Metabolism.*

The Department of Human Physiology continued to change with new appointments and replacements and had 11 faculty members in 1986. Sarah D. Gray [1934–] earned her Ph.D. (Physiology) from UCSF in 1966. After postdoctoral training in Lund, Sweden, and at Duke University, and service on the Physiology faculty of Mt. Sinai School of Medicine, City University of New York (1968–72), she joined the Human Physiology faculty at Davis (1972). Her research interests involve cardiovascular physiology, microcirculation, with special emphasis on developmental studies in hypertension.

Jerry F. Green [1941–] received his Ph.D. degree (Environmental Medicine) from the Johns Hopkins University and joined the Human Physiology faculty in 1971. His major research interests are in cardiovascular and pulmonary physiology.

Andrew M. Goldner [1934–], born in Switzerland, earned his Ph.D. (Physiology) at the George Washington University in 1966. After postdoctoral periods at Harvard University (1966–67) and at Yale (1967–69), he joined the faculty of Human Physiology at Davis. His research interests are general physiology, epithelial transport, and gastrointestinal physiology. In 1975, he left Davis to join the Department of Physiology and to become Associate Dean for Student Affairs at the University of Arizona School of Medicine, Tucson.

Eugene M. Renkin [1926–] received a Ph.D. (Medical Sciences) from Harvard University (1951). After service at Brookhaven National Laboratory, NIH, The George Washington University School of Medicine (as Chairman of Physiology, 1961–63), and Duke University School of Medicine, he became Chair of Human Physiology at Davis in 1974. His research interests are centered on peripheral circulation and transcapillary exchange. In 1974 he was President of the Microcirculatory Society. He was Bowditch Lecturer of APS (1963) and recipient of the E. M. Landis Award (1977) and the B. W. Zweifach Award (1984) of the Microcirculatory Society, and the C. J. Wiggers Award of the APS Circulation Group (1985).

Judith L. Turgeon [1942–] earned her Ph.D. (Anatomy) from the University of Kansas in 1969. After postdoctoral training and service on the Physiology faculty at the University of Maryland, she joined the faculty of Human Physiology at Davis in 1975. Dr. Turgeon's field of research is cellular endocrinology.

Peter M. Cala [1947–] received his Ph.D. from Case Western Reserve University in 1974, and after postdoctoral study at Duke University Medical Center (1974–76), he joined the faculty in Human Physiology in 1976. His research interests are in cell volume regulation and pH and membrane transport.

Richard C. Carlsen [1940–], after service in U.S. Air Force, earned a Ph.D. (Physiology) at the University of Oregon in 1973. After postdoctoral training in neurophysiology at Duke University, he joined the faculty of the Human Physiology (1976). Dr. Carlsen's research interests are in neuronal plasticity and neurotrophic relations.

Fitz-Roy E. Curry [1947–], a native of Australia, obtained a B.Eng. at the School of Chemical Engineering, University of Queensland (1969), and his Ph.D. (Physiology) from Monash University, Victoria, Australia, in 1972. After postdoctoral study at Oxford University, he returned to Monash University. In 1977, he became a member of the Department of Human Physiology, Davis. Dr. Curry's research interests are in microcirculation, transcapillary exchange, and theoretical aspects of capillary permeability.

Dennis W. Waring [1942–] earned his Ph.D. (Physiology) from the University of Kansas in 1970. After service at the Laboratory of Kidney and Electrolyte Metabolism, National Heart, Lung and Blood Institute, NIH (1970–72) and at the Division of Reproductive Biology of The Johns Hopkins University (1973–75), he came to the Department of Human Physiology and was appointed to the In Residence faculty in 1977. His research interests are in the protein hormone secretory mechanisms.

George C. Kramer [1945–] obtained his B.S. (Physics) from the U.S. Air Force Academy in 1968 and served as an Airborne Weather Officer in the U.S. Air Force (1969–72). He earned a Ph.D. degree (Physiology) from the University of Texas Medical Branch, Galveston, in 1979. After a postdoctoral period in the Department of Human Physiology (1979–81), he was appointed Assistant Professor In Residence in 1982. Dr. Kramer's research interests are in microcirculation, the bronchial circulation, pulmonary edema, and fluid resuscitation.

Graduate Studies

At the University of California, graduate studies are

administered by a Graduate Division, which is separate from the academic departments and colleges. Graduate programs are established by formal application to the Graduate Division by the interested faculty, which may or may not be from a single department. Until 1952 graduate studies at Davis were part of the Northern Division (of the Graduate Division) administered by a dean located in Berkeley. Graduate students pursuing studies on the Davis campus were required to register in Berkeley, and degrees were conferred at the Berkeley commencement. In 1952 an associate dean of the Graduate Division was appointed to supervise programs at Davis, and in 1961 the Davis Graduate Division became autonomous.

Graduate training in physiology was initiated on the Davis campus in 1930. Because the Northern Division already had a departmental curriculum in physiology (on the Berkeley campus), this new curriculum was entitled comparative physiology. The faculty group responsible for the curriculum consisted of 32 faculty from several departments on the Davis, Berkeley, and San Francisco campuses and the Scripps Institute of Oceanography at La Jolla. The first degree in comparative physiology for a candidate in residence at Davis was conferred in 1933. In 1959, the curriculum was renamed animal physiology, and cochairmen were named on the Berkeley, Davis, and San Francisco campuses for the local administration of the program. During the period of their existence (1930–67), the programs of comparative and animal physiology granted 41 Ph.D. and 3 terminal M.S. degrees to candidates in residence on the Davis campus. In the fall of 1966, 35 graduate students were enrolled, working toward advanced degrees in physiology. In 1967, the tricampus group in animal physiology was abolished, and a graduate curriculum in physiology was established for the Davis campus. This curriculum provides for the Ph.D. in physiology and two categories of M.S.: Plan I with a thesis and Plan II with a comprehensive examination. Course work and laboratory facilities available are sufficient to allow for a modulation of the graduate physiology curriculum to provide several areas of emphasis (however, the degree remains physiology): general physiology, cardiorespiratory physiology, comparative physiology, systemic physiology, endocrinology, metabolic physiology, and neurophysiology.

The initial Graduate Group in physiology at Davis consisted of 47 faculty from 15 departments located in 4 schools or colleges. In 1985 the Group consisted of 73 faculty from 23 departments in 4 colleges or schools. The operation of the Group is entrusted to a Steering Committee of five members, which is elected annually. The members serve two-year terms, with two or three being elected each year. To ensure broad participation, members of the Steering Committee must represent three colleges or schools. The committee appoints two standing committees (the chairman of each is a member of the steering committee): Membership and Educational Policy. The Membership Committee reviews applications by faculty for admission and also the participation of members of the group (which includes a requirement to offer a graduate seminar at least triennially) to ensure viability of the program. The Educational Policy Committee establishes and reviews the curricula for graduate degrees. It also selects incoming graduate students and arranges for qualifying and thesis committees.

The Steering Committee elects a chairman for itself and for the Graduate Group. The Steering Committee also reviews and refers to the Group applications for membership. The performance of the Group is reviewed annually at a meeting of the entire membership. Chairmen of the Graduate Group in physiology have been: J. M. Boda (1967–69), J. R. Gillespie (1969–71), L. D. Carlson (1971–72), E. A. Rhode (1972–73), L. Rabinowitz (1973–75), I. I. Geschwind (1975–77), R. E. Burger (1977–78), J. M. Boda (1978–80), R. E. Burger (1980–84), E. E. Carstens (1984–85), and L. Rabinowitz (1985–).

The graduate students elect a three-member steering committee annually, which provides an effective and rapid communication between the faculty and graduate students. The chairman of the Student Steering Committee, nonvoting, attends sessions of the Faculty Committee on Educational Policy.

From 1975 to 1985 the program in physiology has carried an average of 67 graduate students, with an average of 7 M.S.'s and 8 Ph.D.'s being conferred annually.

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United States Army Research Institute of Environmental Medicine: First Quarter Century

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In 1986 the U.S. Army Research Institute of Environmental Medicine (USARIEM) commemorates its 25th anniversary; it was officially activated as an installation of the U.S. Army Medical Research and Development Command (USAMRDC) on July 1, 1961, with a mission "to conduct basic and applied research to determine how heat, cold, high terrestrial altitude, and work affect the soldier's life processes, his performance, and his health." In reality it is much older than that, because its history goes back to laboratories established during World War II. It was founded as a composite of elements of the Armored Medical Research Laboratory located at Fort Knox, Kentucky, and of the Environmental Protection Research Division of the Quartermaster Research and Development Command at Natick, Massachusetts; thus, the Institute was originally a merger of a medical and a quartermaster unit. These units and their predecessor laboratories earned a worldwide reputation for excellence as a result of their research efforts during and after World War II, and it is, therefore, appropriate to review briefly their history.

Armored Medical Research Laboratory

The Armored Medical Research Laboratory (AMRL) was established at Fort Knox, Kentucky, February 3, 1942, by authorization of the Secretary of War. It was operated under the control and supervision of the Commanding General, U.S. Army Ground Forces, Washington, DC, from September 1, 1942, until February 3, 1944. On that date the AMRL was transferred from the jurisdiction of the Army Ground Forces to that of the Army Service Forces and was designated a Class IV installation of the Occupational Health Division, Office of the Surgeon General, Washington, DC.

The need for such a laboratory was actually recognized prior to the formation of the armored forces on July 10, 1940; at that time no agency in the army existed for the study of the soldier with respect to his duties in the armored force, primarily in the potentially stressful environment of the tanks used in World War II. When the laboratory was finally established, the scope of the work immediately broadened to encompass such problems as acclimation to heat, physical fitness, atabrine metabolism, vision, fire control, nutrition, foot disabilities, and burns.

Ground was broken for a building to house the laboratory at Fort Knox, Kentucky, on March 12, and it was completed and occupied on September 1, 1942. The laboratory was administered through the Office of the Surgeon General, and during World War II the laboratory operated with 18 officers, 43 enlisted men, and 15 civilians. Willard E. Machle of the Kettering Laboratory, University of Cincinnati, was the first Director (1942–45); during his tenure he entered the service and took command as a Lieutenant Colonel, Medical Corps (MC). He was succeeded by Maj. William B. Bean, MC, in October 1945, whose presidential address to the American Clinical & Climatological Association in 1967 was a delightful personal recollection of his research experiences during World War II.

Climatic Research Laboratory

The Climatic Research Laboratory (CRL) located in the Pacific Mills in Lawrence, Massachusetts, was established on January 19, 1943, under the command of the Quartermaster General as a special laboratory of the Research and Development Branch and was partially staffed by the Surgeon General. It was designed as a laboratory in which all climatic conditions that our soldiers were likely to encounter could be simulated and where their clothing and equipment could be tested. Interestingly, the laboratory was located at this mill site because of the availability of a large cold chamber designed and built for the freeze-cleaning of wool. These chamber facilities, with a temperature range of −112°C to −3.9°C, were leased by the Quartermaster General as the first step in the establishment of the CRL. Human subjects were used extensively in tests designed to obtain accurate physiological and thermal measurements under well-controlled conditions.

Additional facilities were added as the laboratory grew; a jungle chamber was finally completed in August 1944. Despite the delays in construction, the chamber became a valuable asset of the laboratory and provided a temperature range of 7.2°C–60°C. Furthermore it was equipped with water jets capable of producing rain ranging in intensity from one-half inch to ten inches per hour. The facilities and staff of the laboratory were supplemented by members of the Harvard Fatigue Laboratory, which for many years prior to the beginning of World War II had been conducting research on human fatigue and which, even before the establishment of the CRL, had been contracted to test many standard and experimental items for the Quartermaster Corps.

Col. John H. Talbott, MC, previously a senior staff member of the Harvard Fatigue Laboratory, was the first laboratory Director and Commander. H. S. Belding, Ph.D., was the Laboratory Director from 1946 to 1950; he was succeeded by Austin Henschel, Ph.D.,

who served as director from 1951 to 1954. In September 1943 the laboratory consisted of 10 officers, 25 enlisted personnel, and 10 civilians and by September 1945 had grown to 27 officers, 117 enlisted, and 24 civilians. Several prominent American academicians, physicians, and scientists trace their beginnings to the CRL; among these are F. Daniels, Jr., M.D.; G. E. Folk, Jr., Ph.D.; R. E. Forster, M.D.; R. Day, M.D.; A. C. Barger, M.D.; B. Ferris, Jr., M.D.; W. H. Teichner, Ph.D.; H. Hembree, Ph.D.; and J. McGinnis, Ph.D. Some of the very applied problems that these scientists addressed were the effects of environmental temperature and physical activity on the insulation requirements of clothing, the factors that provided the insulative capacity, sweat production under varying environmental conditions, keeping extremities warm in extremely cold weather, cold-induced diuresis, and rewarming.

The CRL published 359 technical reports during 1943–54 and for its wartime activities received the Meritorious Service Unit Award in 1945; yet it was recognized that a more efficient and effective organization would result if the CRL and the Engineering Laboratory at Jeffersonville, Indiana, together with elements of the headquarters section of the Office of the Quartermaster General, could be merged and centralized in adequate facilities. Complementary research programs could be more easily coordinated to effect a comprehensive research and development program in total support of the combat soldier. In June 1952 the idea became a reality when ground was broken at Natick, Massachusetts for such laboratories.

In 1954 the CRL was combined with the Earth Sciences Division, redesignated the Environmental Protection Research Division (EPRD), and became part of the Quartermaster Research & Engineering Command. The division moved from Lawrence, Massachusetts in March 1954 to temporary quarters in Cushing Hospital, Framingham, Massachusetts and finally to permanent quarters in the Research Building at Natick, Massachusetts, on July 1, 1954. Some long-term members of the American Physiological Society who trace their history to the Environmental Protection Research Division and the CRL are E. R. Buskirk, P. Iampietro, D. E. Bass, M. Mager, R. F. Goldman, C. R. Kleeman, A. Ames III, and D. R. Axelrod.

In 1961 elements of the Armored Medical Research Laboratory (Fort Knox) were transferred to Natick, Massachusetts and consolidated with sections of the EPRD to form the U.S. Army Research Institute of Environmental Medicine, which would operate under the aegis of the Surgeon General, U.S. Army. The authorized strength was 10 officers, 23 enlisted men, and 60 civilians, but the actual number was only 45 civilians and military total. The majority of the military personnel were from the AMRL, and most of the civilians were from the EPRD. The Institute was originally organized in three divisions: Cellular Medicine, Climatic Medicine, and Research Support. Capt. R. J. T. Joy, MC, was the first institute commander (CO); David E. Bass was scientific director from 1962 to 1966 and then deputy scientific director until he retired in 1974.

USARIEM, 1961–1986

The first annual report of the USARIEM (fiscal year 1961) contains the names of individuals and titles of research studies that have survived the test of time and remain familiar to many APS members. Some of those who left their mark on USARIEM and saw their careers come to fruition in a variety of institutes and locales are R. J. T. Joy, currently Chief of the History of Medicine Department, Uniformed Services University of the Health Sciences; R. F. Goldman, Vice-President and Chief Scientist, Multi-Tech, Inc., Natick, Massachusetts; Eugene D. Jacobson, Vice-Dean, Academic Affairs, University of Cincinnati College of Medicine; David E. Bass, retired, Newton, Massachusetts; W. F. Blatt, Amicon Corp., Lexington, Massachusetts; and D. G. Therriault, USDA Human Nutrition Research Center, Boston, Massachusetts.

Yet, familiarity with the names of distinguished scientists who helped plot the course of USARIEM is, in a sense, not surprising. What may be more unusual is the persistence of research topics from these very early days that remain militarily relevant, clinically important, and scientifically significant. Cold-induced cyclic vasodilation in humans was the topic of an entry in the first USARIEM Annual Report and the topic of a presentation of a recent FASEB symposium entitled *Man in the Cold.* In 1961 Dr. Jacobson studied the effects of heat stress on visceral blood flow and intestinal absorption; today we are studying this problem with sophisticated stable isotope methodology. A. H. Woodcock composed a report on heat transfer between clothed humans and the environment; to this day this research topic is of prime importance to the Biophysics Branch of the Military Ergonomics Division. W. F. Blatt reported the effects of exposure to heat and cold on coagulation and fibrinolytic mechanisms; today the coagulopathies of heat stroke, frostbite, and hypothermia remain topics of active investigation. R. E. Clark and G. Clark wrote in 1961 of central nervous system processes in temperature regulation, a subject that remains one of the more popular themes of current physiology. In 1962 S. Moroff and D. Bass studied the effects of overhydration on the ability to work in the heat and heat acclimation; hyperhydration, as well as euhydration and hypohydration, continues to be a major focus of USARIEM's physiological research program. As early as 1962 H. Hanson, G. Fonseca, and R. Breckenridge illustrated the usefulness of a theoretically derived prediction system for tolerance times for work in the heat; today, after the entry of data from literally thousands of heat/exercise tests, a hand-held computer is being developed for line issue and use for the same predictive function.

The history of USARIEM is replete with reports of participation in countless field studies. In fact, USARIEM investigators have always been anxious to test their hypotheses first in the laboratory, then in the chambers, and finally in the field. One of the first of these studies was conducted in 1962 and comprised 450–500 test subjects who deployed to the Panama Canal Zone for maneuvers and who were monitored closely by USARIEM physicians and scientists for bacterial culture type in skin lesions. From its not-so-modest inception, the USARIEM field research program has traveled to Germany, Korea, Hawaii, Egypt, South America, Alaska, and most continental United States military installations in determined pursuit of

environmental test scenarios designed to mimic real world military situations.

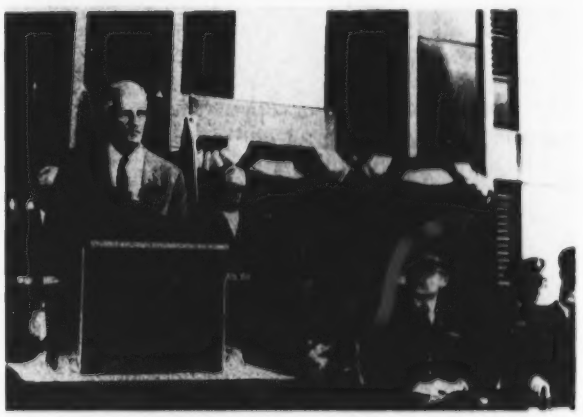
Collaborative research with the multitude of institutions and universities in the Boston area has been another hallmark of USARIEM's policies. As early as 1963, USARIEM scientists had collaborative research projects with the Peter Bent Brigham Hospital; this was a joint effort to isolate and characterize the urinary gonadotropins. With the Thorndike Laboratories of Boston City Hospital a study was conducted to investigate the in vivo metabolism of the canine thyroid gland. The USARIEM and the Boston University Medical School jointly examined a method for the electrophoretic separation of the formed elements of blood. The Massachusetts Institute of Technology and USARIEM joined resources to assess the role of carnitine in lipid metabolism. Since these seminal collaborative efforts the administrative and research staff of USARIEM have endeavored to nurture and increase these productive associations. Recently, the Heat Research Division of the USARIEM and the Nutrition-Pathology Unit of the Boston University School of Medicine completed a study on the comparative absorption rates of water and glucose-electrolyte solutions during exercise in the heat and after mild hypohydration.

It is important to recall that during these formative years, USARIEM staff members worked under less-than-ideal conditions in terms of laboratory, office, and chamber space. What little of each was available was provided by the Quartermaster Research and Engineering Command, Natick, Massachusetts and leased commercially at Mercer Road, Natick, Massachusetts, where the behavioral sciences contingent was located. In his foreward to the 1965 Annual Progress Report, James E. Hansen noted, "Due to the foresight and efforts of the U.S. Army Medical Research and Development Command (USAMRDC) and LTC William H. Hall, MC, the former Commanding Officer of USARIEM, a 3½ million dollar building is under construction." In addition, a major reorganization was announced, expanding USARIEM to six divisions; under the plan the USARIEM research staff was organized around the scientific disciplines experimental pathology, behavioral sciences, military ergonomics, physiology and medicine, biochemistry and pharmacology, and support.

The mid-1960s were characterized by extreme optimism and intense activity. Pharmacological intervention to reduce the impact of environmental extremes came into vogue. Such studies as "The role of exogenous aldosterone in heat acclimatization and work in the heat" and "The effects of acetazoleamide on the adverse effects of acute altitude exposure in human subjects" were completed in 1965; the latter was conducted in the Colorado mountains with a Special Forces group. In 1966 it was announced that on July 1, 1967, a subsidiary of USARIEM would be opened at Fairbanks, Alaska on the grounds of Fort Wainwright. It would be called the Arctic Medical Research Laboratory and would specialize in research on frostbite, hypothermia, and other injuries associated with military operations in cold environments to improve current practices, equipment, and doctrine. Also in 1967 USARIEM hosted an international symposium on "Biomedical Problems Associated with Living and Working at High Terrestrial Elevations." The papers presented at this meeting were published in the form of a monograph edited by A. Hegnauer, Research Program Officer, USARIEM; this edition continues to be quoted in the current scientific literature, attesting to the quality of the speakers and their research. The divisions of USARIEM were upgraded in governmentese to laboratories; research resources were abundant as the late 1960s unfolded.

A new and spacious building (76,000 square feet) was occupied in March 1968 and dedicated on October 17, 1968. Luminaries officiating at the dedication ceremony included Lt. Gen. A. W. Betts, Surgeon General, U.S. Army; Maj. Gen. J. Blumberg, CO, U.S. Army Medical Research and Development Command; Brig. Gen. F. Gerace, CO, U.S. Army Natick Laboratories; and Col. J. Hansen, CO, USARIEM. The keynote speaker was Edward Adolph, Emeritus Professor of Physiology, University of Rochester Medical School. Dr. Adolph is the author of the classic work entitled *Physiology of Man in the Desert,* which was based largely on his studies conducted for the U.S. Army during World War II. Currently well into his nineties, Dr. Adolph can still be seen in attendance at various professional meetings around the country.

In February 1969, two altitude chambers, with an adjoining airlock, were placed in operation; altitudes up to 7,620 meters, temperatures from −22°C to 50°C, and humidity from 20% to 80% can be simulated in



Top: U.S. Army Research Institute of Environmental Medicine. *Bottom*: Edward F. Adolph, Professor of Physiology, keynote speaker at dedication of USARIEM building.

these chambers for extended periods of time. Up to 20 subjects, technicians, and investigators can be housed in the larger chamber. Additionally, this sophisticated facility housed 14 environmental chambers with a range of temperature from −40°C to 60°C. By this time USARIEM had accommodated its expanded mission and staff by forming eight research laboratories and a single support division: medicine, behavioral sciences, military ergonomics, biochemistry-pharmacology, physiology, military stress, Arctic medical research, and experimental pathology.

Whereas the USARIEM of the 1960s was characterized by growth, development, and maturation, the emphasis during the 1970s was placed on military relevance. In fact, as early as 1970 the Annual Progress Report stated that in 1971 new work units to encompass USARIEM research programs would be formulated, and these work units would be centered around militarily relevant problems. When Col. L. G. Jones, MC, assumed command of USARIEM in July 1971, a transition of the Institute had already begun, and several new initiatives were developed. One of his avowed goals was the dissemination of USARIEM's combined knowledge, information, and expertise to line units and Department of Defense and Department of Army schools that could benefit directly from lectures, briefings, and consultations by USARIEM staff. To this end a campaign was initiated to make known to the Department of Army elements USARIEM's ability to offer guidance on how to reduce the impact of the environment on military exercises, basic and advanced training, and doctrine. What began modestly as lectures to students at the Command and General Staff College, Fort Leavenworth, Kansas, the Medical Field Service School, Fort Sam Houston, Texas, and the Flight Surgeon's Course, Fort Rucker, Alabama has evolved into an imposing and comprehensive network of classes, lectures, briefings, and consultations that have reached to the highest level of army command. Dozens of USARIEM staff members have delivered guidance on coping with environmental effects to literally tens of thousands of troops about to deploy to such environments. Whether it be a lecture on the prevention of cold injury to elements of the 25th Infantry Division about to deploy to Korea or a briefing on desert maneuvers to members of the 101st Airborne Division about to deploy to the Mid East, USARIEM staff members continue to perceive this information dissemination mission as one of their top priorities.

In the early 1970s the maturation of USARIEM took on a decidedly international flavor with visiting scientists from literally all regions of the world. Represented at USARIEM during this period were the Army Personnel Research Establishment, Farnborough, UK, the Israeli Defense Forces, the Tokyo Medical College, and the All India Institute of Medical Sciences. These were not one-way relationships, however, as USARIEM scientists likewise visited and, in some cases, worked in these locales for periods up to 2 years.

During the early to mid-1970s the public was beginning to cast a concerned, if not suspicious, eye toward science and scientists. Annual Progress Reports contained such statements as "In conducting the research described in this report, the investigators adhered to the Guide for Laboratory Animal Facilities and Care, as promulgated by the Committee on the guide for Laboratory Animal Resources, NAS-NRC." For human work the comparable statement read, "In conducting the human studies reported herein, review, approval, and execution of all protocols was obtained in consonance with Army Regulation 70-25 and other laws dealing with human experimentation." Versions of the same statements continue to appear in all USARIEM publications. All animal protocols were and are carefully scrutinized and evaluated by a USARIEM Laboratory Animal Care and Use Committee before approval by the Commander. This committee was formed in 1975 and thus predated similar committees at many universities and medical schools. Likewise the health and safety of test subjects have always been the primary consideration in the design of USARIEM human experiments. Thus, human use protocols were and are reviewed carefully not only by a USARIEM Human Use Review Committee but also by a USAMRDC committee that meets on a scheduled monthly basis. No protocols may be initiated at USARIEM without the prior review and approval of the respective authoritative committee; health, safety, and comfort of test subjects continue to be of utmost importance in the design of human research protocols.

During the mid- and late 1970s, with the increasingly predominant theme of military relevance as a backdrop, the research program of USARIEM was further adjusted to focus on the military operational requirements of troops serving in cold weather areas and in desert, jungle, and mountainous environments. These precepts were expanded, consolidated, and institutionalized under the capable command of Col. H. Dangerfield, MC. During this period it became common for groups of USARIEM investigators and technical support personnel to establish working relationships with many line units, key medical personnel, and troop commanders. The purpose of these working relationships was access to large-scale military training exercises for USARIEM personnel, usually in an unobtrusive observational role. Integration into these operational scenarios proved invaluable to both the USARIEM research and information transfer programs. Living with the troops for weeks at a time in all types of global environments permitted a first-hand view of the problems encountered by operational forces under such conditions. These observations were translated into requirements, research themes, and ultimately, research protocols of the highest military relevance and priority. It should be noted in passing that participation in these training exercises also afforded the opportunity for USARIEM scientists to acquire first-hand literally thousands of the photographs and slides that would ultimately be incorporated into briefings and lectures on reducing the environmental impact on military operations.

In keeping with the emphasis on military relevance and the solution of military problems, the Institute was reorganized in 1978 around mission areas rather than scientific disciplines: Altitude Research Division, Exercise Physiology Division, Heat Research Division, Health and Performance Division, Military Ergonomics Division, and an Experimental Pathology Division that incorporated the Cold Research Program of the now defunct Arctic Medical Research Laboratory. Support elements were grouped in the Research Support Divi-

John T. Maher Laboratory, Pikes Peak Facility.

sion. The Altitude Research Division assumed administrative control and responsibility for the John T. Maher Laboratory, Pikes Peak Facility and continues to make an annual field research trip to the laboratory during the late spring–early summer period.

Over the years USARIEM missions have flourished and expanded. In the mid-1970s a new mission was given to the Exercise Physiology Division: physical fitness requirements and training. A mission for information dissemination was codified and formalized. In the early 1980s part of USAMRDC's mission in the medical aspects of chemical defense was earmarked for USARIEM. Most recently, a research initiative and formal mission in the area of military nutrition has been incorporated at USARIEM. Clearly, there is no shortage of things to do and problems to solve.

Changes continued. In the very late 1970s the Military Ergonomics Division was subdivided into a Biophysics Branch and a Physiology Branch to address more effectively its bimodal mission. In the early 1980s the Experimental Pathology Division became the Cold Research Division to express more adequately its research mission. Subsequently, it has been administratively separated into a Cold Injury Branch, an Experimental Pathology Branch, and an Animal Care Branch. The Research Support Division is now composed of five branches including computer, budgetary, and administrative services. The military mission of the institute is more explicitly stated. For example, during the 1970s, work units were categorized under funding titles such as "Research in Biomedical Sciences." Now these titles read "Research on *Military* Disabilities, Injuries, and Health Hazards" or "Medical Factors Limiting *Soldier* Effectiveness." When the command of USARIEM passed in 1982 from Col. Eliot Pearlman, MC, to Col. Ernest Irons, Medical Service Corps (MSC), it marked the first time that a nonphysician took the reins of the Institute. This relatively new tradition continued under the recent direction of Col. Brendan E. Joyce, MSC; the Institute is currently commanded by Col. David Schnakenberg, MSC.

In the foreword to the USARIEM Annual Progress Report of 1965, Col. Hansen, CO, wrote, "Our future is bright." In 1986 the USARIEM staff believes that these words still ring true. In its first 25 years USARIEM has collectively published nearly 1,000 scientific papers; the vast majority of these were published in the peer-reviewed scientific literature. The current USARIEM staff looks forward to increased productivity in the next 25 years. The research divisions of USARIEM continue to be engaged in state-of-the-art research designed to reduce the impact of environmental adversities on the United States soldier; scientifically and militarily these research initiatives give promise to many years of continued accomplishment.

The future was bright in 1965; it is bright in 1986. During the early to mid-1980s an outstanding group of new young investigators has been recruited from some of the country's outstanding physiology departments and laboratories. Into their collective and capable hands go USARIEM's plans and hopes for continuing the internationally recognized excellence that has been characteristic of USARIEM since its inception. It is repeatedly emphasized that the most vital component of any organization is its human resources. With its current support, technical, research, and administrative staff, USARIEM looks forward to another quarter century of scientific accomplishments, scholarly excellence, professional recognition, and, most importantly, important contributions to the health and safety of United States soldiers in any global environment.

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History of Physiology Department at Medical College of Wisconsin: 1921–1985

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The Medical College of Wisconsin, a private medical school, generally permits its departments (within budgetary limits) relatively wide latitude in conducting its internal affairs. However, external factors can and do strongly affect the fate of individual departments and are therefore relevant to the history of physiology at that institution. Material has been included that relates to other departments of the university, to administrative practices, to physical plant and location of the school, and to the character of the institution itself as it evolved. Furthermore, in keeping with Emerson's thesis that history is primarily biography, emphasis has been placed on the role of individuals rather than the simple concurrence of events.

Marquette University School of Medicine, which in 1967 became the Medical College of Wisconsin (MCW), had an early history that, as with many midwestern medical schools, was rather hectic. As an early chronicler said, the present school developed out of the "ruins" of two proprietary medical schools (8). The Wisconsin College of Physicians and Surgeons began in 1893 and the Milwaukee Medical College and School of Dentistry in 1894. Students were admitted with insufficient credentials, some professors held two or more chairs simultaneously, and standards were decidedly lenient (1).

Abraham Flexner made a site visit to Milwaukee in 1909 and gave both schools a very poor rating. In 1911 the American Medical Association Council on Medical Education made strong recommendations for improvement. When no changes occurred and the ratings of the schools were in apparent jeopardy, the students became restless; in 1912, all the students of the Milwaukee Medical College at 9th and Wells streets withdrew in a body, marched to the Wisconsin College of Physicians and Surgeons at 4th and Reservoir streets, and enrolled at that school. The former institution then ceased to exist (1). Because the Wisconsin College was financially insolvent, some prominent members of the Milwaukee medical profession approached Marquette University and promised to support efforts to form a university-oriented medical school. In January 1913, Marquette University purchased the buildings and equipment of the Wisconsin College of Physicians and Surgeons and organized the Marquette University School of Medicine. Four full-time professors were hired: H. C. Tracy chaired anatomy, histology, and embryology; A. F. Boretti, pathology and bacteriology; C. J. Farmer, biochemistry; and John Van de Erve (M.D., Rush Medical School), physiology and pharmacology (8).

Affiliations were established with St. Josephs Hospital and Milwaukee County Hospital, faculty buildup proceeded, and the caliber of instruction improved. In 1918, stimulated by a gift of $330 thousand from the Carnegie Foundation, $1 million was raised for endowment of the school, and in 1922 another $1 million was given by the Cramer Foundation. The Marquette University School of Medicine, its future apparently assured, was now finally on a more solid basis (5–7).

The Early Years of Physiology at Marquette University Medical School: 1922–1952

From 1913 to 1920, there was a combined Department of Physiology and Pharmacology but apparently no organized curriculum. In 1919 Dr. Van de Erve, who was an ordained Presbyterian Minister as well as a physiologist, resigned to become the first salaried, full-time Chairman of Physiology at the Medical University of South Carolina, where he remained until his death in 1944. He was succeeded in 1919 by Benjamin Schlomovitz, who became head of the combined department. In 1920, Percy F. Swindle, a physiologist, was appointed Associate Professor in the combined department, and in 1921 a Department of Physiology was established, with Dr. Swindle as Professor and Chairman.

There now appeared for the first time an organized curriculum of physiology instruction with lectures and lab demonstrations in most of the important physiology subspecialties. The entire program in basic sciences was given a big boost in 1932 with the completion of the new Cramer Memorial Building on the Marquette campus near 15th and Wisconsin avenues. This modern building provided much more spacious and better-equipped laboratories. This was particularly welcomed by the Physiology Department, whose quarters over a butcher shop at the 4th and Reservoir building were dismal. Constructed during the depth of the Depression, the new building cost $435,000 and permitted an increase in freshman enrollment from 75 to 100.

Leonard Deysach and Edgar End, practicing physicians in Milwaukee, became part-time physiology instructors in the 1930s. Dr. End received his M.S. in physiology under Dr. Swindle in 1942. During the years of Dr. Swindle, the faculty of the basic science departments usually consisted of two or three members and an occasional student assistant recruited to help with lab experiments. During most of these years, a two-quarter course in human physiology was given in the sophomore year. Dr. Swindle gave most of the lectures, with Dr. Deysach and Dr. End helping out occasionally. In keeping with his German training, Percy Swindle often supplemented his lectures with animal demonstrations. In the early 1930s, regular student laboratory sessions were begun, and students participated in ex-

Top: first home of Marquette University School of Medicine, 4th and Reservoir streets, Milwaukee, 1913–1932. *Bottom:* second home of Marquette University School of Medicine on Marquette University Campus on 15th Street near Wisconsin Avenue, Milwaukee, 1932–1978.

periments on isolated tissues, frogs, rabbits, and occasionally dogs.

Dr. Swindle was an interesting and unusual man. Part Cherokee Indian, he was born in 1888 in a small town near Newtonia, Missouri. As a boy he roamed the Ozark Mountains of Missouri, was proficient in Indian lore, and became an avid fisherman and hunter with considerable knowledge and interest in animals and natural biology. In the Missouri hills feuds were common, and bushwhacking was an acceptable mode of settling a dispute. In his later teens, Percy was mistaken for a member of a feuding family and shot in the leg by an unfriendly neighbor. He walked with a cane for many years, but in time the disability was less marked and in later life practically disappeared. He was determined on a higher education; though largely self-taught, he passed the entrance examinations at the University of Missouri, where he earned B.S. and M.S. degrees in biology. He then resolved on an advanced degree from a German university, which at that time was considered the peak of academic achievement.

Swindle's credentials were forwarded from the University of Missouri, and in 1912 he was admitted to the Kaiser-Wilhelm University (later the Humbolt University of Berlin). In Berlin he supported himself by dishwashing and other menial chores. Class lectures were few and students were forced to read and study practically on their own. As was the custom at most German universities, he was exposed to the "masterful neglect " of the Herr Professors. While in Berlin he came under the influence of Werner Spalteholdz, the famous anatomist who was a pioneer in visualizing pathways of arteries, capillaries, and veins in cleared tissue preparations; Dr. Swindle continued his interest in this type of circulatory study throughout his lifetime. He made numerous biologic models that demonstrated the three vessel types in many tissues and organs of the body, and his collection is still intact at the Milwaukee Public Museum.

In Berlin, Swindle also spent much time in the training of lions and tigers at the Hagenbeck Zoological Gardens, the principal supplier of performing animals to circuses. While at the University of Berlin, he also worked with Koffka and associates, the animal psychologists who developed Gestalt psychology. In 1917, because of war-time tension, it was questionable whether he could complete his studies. Fortunately he finished his oral exams and received notification of satisfactory completion on a sheet of paper, folded twice, which denoted it as his Ph.D. diploma [in Greek, di (two) and ploma (to fold)]. After returning to the United States, he spent a semester teaching at Harvard University and then took a position at the University of Missouri, Department of Physiology.

He was drafted into the military in 1918 and served as an examiner at army induction centers, but because of his Indian heritage, he was not considered a citizen and for reasons that are not clear could not obtain his release until 1920.

At that time he noticed an advertisement of an opening in the Department of Physiology and Pharmacology at Marquette University. He applied and was accepted and appointed to the faculty in 1920. He was married and with his wife and two children made Milwaukee his permanent home. In 1921 a separate Physiology Department was formed, with Dr. Swindle as Professor and Chairman. In keeping with the mandatory retirement policy of the university, Dr. Swindle resigned the Chairmanship of Physiology in 1951 at the age of 67. (Mandatory retirement for the chairmanship was later changed to 65.) However, he remained actively engaged in research on blood vessel injection and visualization for 10 more years, working with William P. Maher, a long-time colleague on the Dental Faculty. He died in 1972 at the age of 87.

During his tenure, Dr. Swindle was involved in active

Left: Percy F. Swindle, first Chairman of Physiology, 1921–1952. *Right:* James J. Smith, second Chairman of Physiology, 1952–1980.

investigation in several areas, including animal instincts and sensations, optical illusions and afterimages, strychnine reversal of the ammonia reflex in rabbits, and mechanical factors contributing to fluid exchange. However, his primary interest was in the structure of the microcirculation, particularly in vessel architecture of the nasal passages and eye. A lengthy description of Dr. Swindle's research activities and a fairly complete list of his publications are available (4). He received awards from the American Medical Association and from the American Academy of Ophthalmology and Otolaryngology for his work on blood vessel visualization.

Swindle was a recognized authority on wild animals and animal psychology and served as chief consultant for the Milwaukee Zoo for many years. His ability to handle animals was legendary. On occasion during his earlier years, he would bring a lion into the classroom and tie him near the podium while he conducted his lecture. When asked later if this wasn't dangerous, he stated, "not at all—I arranged for the floor to be highly polished so the lion couldn't really navigate." Obviously Dr. Swindle was one of the early advocates of the old principle that to teach medical students successfully, you must first get their attention.

Edgar End, M.S., M.D., Assistant Professor of Physiology from 1935 to 1952, was an active researcher in deep-sea diving and hyperbaric medicine. As a youngster, End and two colleagues built experimental underwater helmets connected to garden hoses and tire pumps, and with this primitive apparatus they explored the depths of stone quarries near Lannon, Wisconsin, a suburb of Milwaukee. While in the Physiology Department, encouraged by Dr. Swindle, End invited a graduate engineer and experienced diver, Max Knoll (from the Massachusetts Institute of Technology), to come to Milwaukee and work with him on different helium-oxygen breathing mixtures. They worked first on animals and then on themselves in the hyperbaric chamber at Milwaukee County Emergency Hospital. They were among the first to show that with helium, there was almost a complete absence of narcotic effects and decompression times were speeded up about 20-fold (2, 3). Max Knoll then made a series of dives, supervised by Dr. End, culminating in a 420-foot dive to the bottom of Lake Michigan, 12 miles southeast of Port Washington on December 1, 1937. This broke the national and world diving record (3). At this time End and Knoll also produced the first self-contained underwater breathing apparatus (scuba). Much of the specialized gear used by the navy in World War II was built under the supervision of Edgar End. In later years Dr. End conducted research on nitrogen release during decompression and treated practically all of the "bends" cases occurring in divers and tunnel workers in this part of the country. In 1967–68, for example, over 700 bends cases were treated under his direction in the Milwaukee County Hyperbaric Chamber.

Other basic scientists who played leading roles in the medical school during those years include Harry Beckman, Professor and Chairman of the Pharmacology Department, who wrote a very popular *Pharmacology in General Practice* text that went through many editions. He retired in 1965 and was succeeded by Harold A. Hardman, the current Pharmacology Chairman. Armand J. Quick joined the faculty from Cornell University Medical School in 1926 and was named Professor and Chairman of Biochemistry. He became an eminent authority on hemostasis and retired in 1972 after a 50-year teaching and research career. Eben C. Carey, Professor of Anatomy, was succeeded in 1947 by Walter Zeit, an outstanding figure in the history of the medical school. Dr. Zeit was also Associate Dean for preclinical sciences and devoted considerable time and energy in behalf of other basic science departments. A colorful and effective teacher and a dedicated man of considerable intelligence and prudence, he contributed in many ways toward the academic advancement of the fledgling medical school. He ably and effectively represented the basic science departments in their relations with the rest of the university, the alumni, and the medical profession of the community. In the social circles in which he moved, he was known as "the champ" because of his uncanny (and lucrative) skill at pinochle.

Growth Years of Physiology at Marquette: 1952–1980

In the postwar years, a number of factors contributed to bring about revolutionary changes in the medical school. A decision was made by Rev. Edward J. O'Donnell, President of Marquette University, and John S. Hirshboeck, the newly appointed Dean, to greatly strengthen the medical school faculty, to develop better affiliations with the two main teaching hospitals (Milwaukee County and the Veterans Administration Hospital), and to build a private University Hospital for the Medical School. These two leaders worked diligently toward these ends, and the efforts they set into motion were ultimately rewarded with a good measure of success. Even the University Hospital goal was achieved, albeit much later, when the Froedtert Memorial Lutheran Hospital was completed in 1982. This resolve of the Marquette University administration, the expansion of the National Institutes of Health (NIH) extramural research and training grant program, and the enlightened leadership of Dr. Hirshboeck conspired to fuel unprecedented growth of the basic and clinical departments. Particularly notable was the growth in the Physiology program.

Dr. Hirshboeck, who had a master's degree in physiology, had considerable insight into the problems of

basic and clinical faculty and, despite the many difficulties that accompany rapid growth, consistently and intelligently fostered sound academic advancement of the medical school. It is probably fair to say that Dr. Hirshboeck, who is now retired, more than any other single individual is responsible for ushering the Medical College of Wisconsin into the modern era of medical education and research.

Physiology Personnel

After the retirement of Dr. Swindle in 1952, James J. Smith (M.D., St. Louis University; Ph.D., Northwestern University) was appointed Professor and Chairman of the Department. Shortly after completion of his physiology training, Dr. Smith was mustered into the Air Force, became a flight surgeon, and after a year in aviation physiology research at the Wright Field Aeromedical Lab spent three years as Director of Research at the U.S. Air Force Medical School and Research Institute at High Wycombe, England. During that assignment he was involved in the investigation of medical problems incident to high-altitude flying such as aviator's bends, anoxia, air sickness, explosive decompression, night vision, and air-sea rescue problems. After the war he was on the Physiology Faculty of Loyola University School of Medicine and from 1950 to 1952 was Associate Clinical Professor of Pharmacology at George Washington University School of Medicine, where he began (with Paul K. Smith, Professor of Pharmacology) some studies into the mechanisms of irreversible circulatory shock. This remained his primary research interest for many years.

After the resignation of Dr. Swindle, the remaining two members of the Department, Dr. Deysach and Dr. End, resigned their positions because of increasing commitments of their medical practices. Although Dr. Swindle remained on the teaching faculty for two more years, it became necessary to build the remaining Department staff practically from scratch. A search was made and two new physiology faculty, Alvin F. Rieck and Howard M. Klitgaard, were appointed in 1951 and 1953 respectively.

Al Rieck was born in Herington, Kansas in 1919 and received a B.S. degree in biology from Kansas State College in 1940. At Kansas State he came under the influence of John Breukelman, a renowned teacher of biology who inspired many students to outstanding research careers. However, World War II intervened and Rieck volunteered for service in the navy. He became a navy pilot and for two years flew torpedo bombers in the South Pacific. He was in heavy action at Okinawa, the Japanese seas, and Midway, among others, was shot down at Guam, and had numerous decorations for valor and service "beyond the call."

In resuming his career, Rieck took a master's degree in biology at Marquette University under Raymond H. Reis and then went on to Princeton University, where he received his Ph.D. in 1951. At Princeton he worked under H. F. Blum on the effect of various forms of radiation on cellular differentiation. He was appointed to the Physiology faculty at Marquette University School of Medicine in 1951, the first appointee of Dr. Smith, the new Chairman. For the next 21 years he was a key member of the Medical College faculty and highly respected not only for his research but as a teacher of medical and graduate students. His primary research interests were cell biology and renal function, and he became widely known for investigations in the field of cell division and particularly for his pioneer work on the inhibitory effects of ultraviolet light on the growth of cancer cells. He held an American Cancer Society National Research Scholarship (1953–58), an NIH Career Development Award (1962–67), and was Director of the Mt. Desert Island Biological Lab (1960–65) and Visiting Professor at the University of Edinburgh (1965–66).

His prime interests included the welfare and training of graduate students. He was Director of the Graduate Program of the Department for many years. Among his own graduate students were James A. Belli, M. E. Blaskovics, James W. Keller, Thomas J. Flatley, Anthony J. Steffek, Thomas W. Sneider, Michael J. Dunn, and Dale R. Johnson. All of these men became active and productive academic investigators. In 1972 Dr. Rieck was troubled with symptoms of peripheral arteriosclerotic disease (a familial affliction), which became progressively worse and ultimately caused his death in 1973 at the age of 54. He bore his final illness, as he did everything else, with courage and humility. Al Rieck was a scholar, a teacher, and a gentleman. In tribute to his contributions to this Department and to the school, a memorial lectureship was established in his name.

Howard M. Klitgaard was born in Harlan, Iowa in 1924. His collegiate education, begun in 1942 at Denver University, was interrupted shortly thereafter by service in the army. After basic and medical aide training he was shipped overseas and spent the war years as an infantryman and as anesthetist with the 109th Evacuation Hospital in Patton's Third Army. After the war, Klitgaard enrolled at the University of Iowa, where he received his B.A. and M.S. degrees and in 1953 his Ph.D. in physiology. At Iowa he worked with Sam Barker investigating numerous iodinated pheno-oxyacetic acids for their thyroxine-inhibitory effects. His initial work was on oxygen consumption of selected tissues from normal and thyroxine-treated rats; the graphs from these experiments are still reproduced in endocrine textbooks.

Dr. Klitgaard was appointed to the MCW Physiology faculty in 1953 and continued his investigations of elimination pathways, transportation forms of thyroxine and iodine, enzymes responsible for the rate-limiting hormonal reactions, and the influence of thyroid hormone on somatomedins. Aside from his long and productive record in endocrine and metabolic research, Dr. Klitgaard trained a number of graduate students, many of whom have gone on to prominent positions in the academic world. Among these are Peter A. Kot, Robert F. Loizzi, Read R. Nielson, Thomas W. O'Brien, Lawrence F. Kress, Roberto Galindo, Richard J. Declusin, Mary F. (Christiano) Ruh, Thomas S. Ruh, Ken Chun, Walter F. Ward, John P. Mullooly, Donna Van Wynesbergh, Kathryn Gaspard, and Robert Wondergem.

Dr. Klitgaard served highly important administrative functions within the Department. He was Vice-Chairman and co-investigator of the departmental graduate training grant during the entire length of this important grant (1959–74). Beyond this, his lasting influence

stemmed from his unbounded interest and enthusiasm in science and in the giving of himself to the Department and the university. He helped countless students and young faculty through all manner of difficulties. He gave unselfishly without counting the cost.

The achievement of effective teamwork in a department usually depends on the tone and example set by the more respected members of the senior faculty. In the Department of Physiology during those years, there was a genuine spirit of mutual cooperation that helped to bridge the periods of stress and difficulty. While the faculty at large contributed to this favorable state, it was unquestionably the unusual dedication, loyalty, and unselfishness of Dr. Klitgaard and Dr. Rieck that set the pace and created the atmosphere. Whatever success was achieved in the Department during these years is mainly attributable to these two remarkable men.

In the years that followed, with the increase in outside grants, there was steady growth in research and graduate training activities and in faculty size. Donald A. Roth (M.D., Ph.D., University of Wisconsin) served as instructor for two years before joining the clinical staff of the Veterans Administration Hospital. Andrew A. Pandazi (Ph.D., University of Illinois) served as instructor in Physiology and then enrolled in medical school toward his M.D. degree. The next two appointees, William J. Stekiel (Ph.D., Johns Hopkins) and Lyle H. Hamilton (Ph.D., University of Iowa), became key, long-term faculty members of the Department.

Dr. Stekiel, who had a doctorate in biophysics, trained under Martin G. Larrabee at the Johnson Department of Biophysics at Johns Hopkins University. His primary research interest was the metabolism of sympathetic ganglion cells and its role in the support of cellular electrophysiology. In later studies, Dr. Stekiel's work focused on the electrophysiological properties of vascular smooth muscle and the relationship between cell membrane potential and the mechanical properties of these vessels. Dr. Stekiel and his students were the first to show that during hemorrhagic shock in the rat, there was marked depletion of adrenergic neurotransmitters in mesenteric arterioles, indicating that this was probably the cause of the loss of compensatory mesenteric vasoconstriction in irreversible shock in this animal.

He trained a number of graduate students who ably pursued this basic study of sympathetic and vascular smooth muscle physiology, including Leonard A. Rozek, William F. Willems, David R. Harder, and Julian H. Lombard. Dr. Stekiel is a scientist's scientist, an enthusiastic, exacting, indefatigable investigator, dedicated to the highest academic ideals. He directed the student laboratories during most of this period and supervised the transformation from older student lab techniques to the modern electronic recorder equipment now used in the Department. He played a highly important role in the development of the Department of Physiology.

Lyle H. Hamilton was a graduate student of Steven M. Horvath and received his Ph.D. from the University of Iowa in 1954. He spent three years at the University of Saskatchewan, where he worked primarily in the area of blood and leukocyte physiology and the effect of heparin on leukocyte response. He joined the faculty of the Physiology Department in 1957 as Assistant Professor and Chief of the Physiology Section of the Research Service at the Veterans Administration Medical Center. In the following years, Dr. Hamilton's research dealt with respiratory, environmental, and exercise physiology. He studied the stress response and its hematological manifestations and made noteworthy contributions to the field of gas chromatography. In later studies he investigated the effect of respiration on transthoracic impedance, methods of blood gas analysis, pulmonary function measurements during exercise, and the effects of bronchodilators and nasal decongestants on pulmonary and nasal gas flow resistance. He trained a number of graduate students and postdoctoral fellows, including D. W. Melville, R. L. Jones, R. L. Wiley, C. A. Dawson, M. B. Moran, and David A. Rickaby. As an acknowledged authority in respiratory physiology, Dr. Hamilton co-authored (with Dr. N. B. Slonim) a successful textook on *Respiratory Physiology*, which has gone through four editions (Mosby and Company).

In 1967, with the cooperation of R. C. Kory, Head of Research at the Milwaukee VA Medical Center, a Clinical Physiology Section of the Physiology Department was established at this Hospital with Dr. Hamilton as Chief. Its function was to assist the clinical staff of the Hospital in the design and execution of their investigative projects and to establish a graduate program toward the Ph.D. degree in Physiology at the VA Hospital. This graduate basic science influence contributed substantially to the development of the Milwaukee VA research program into one of the strongest within the VA system.

Robert W. Rasch (M.D., Ph.D., University of Chicago) joined the Physiology faculty in 1960. His research interests were primarily in the chemistry of cellular reproduction. Using cytophotometric techniques, he developed theoretical models that provide for stoichiometry in the Feulgen reaction as it applies to the DNA in nuclei. Because of his unusually broad grasp of cellular, organ, systemic, and human physiology, Bob Rasch was a highly effective teacher of both medical and graduate students. He left the faculty in 1979 to become Professor and Chairman of Physiology at the newly organized East Tennessee University Medical School in Johnson City, Tennessee. Barbara J. Pettit received her Ph.D. under Dr. Rasch in 1967.

David W. Glenister (Ph.D., Princeton University) spent three years with Dr. Eugene Landis at Harvard and joined our Physiology Department in the early 1960s. Dr. Glenister's previous experience with Dr. Landis' unique medical course was of considerable help in the reorganization of our own student laboratory teaching. Dave was a highly knowledgeable and effective teacher. His research, which was a continuation of his earlier work at Princeton, was primarily concerned with the role of adrenal steroids in stress.

Henry F. Edelhauser (Ph.D., Michigan State) joined our faculty in 1966. His research interests were in physiology of the eye. His joining of our faculty coincided with the appointment of Richard O. Schultz as the new Professor of Ophthalmology. Over the next years Dr. Edelhauser and Dr. Schultz collaborated in the development of an outstanding eye research program. Henry Edelhauser and his students studied cor-

neal physiology, including factors influencing corneal transparency, mechanisms of cataract development, composition of intraocular fluids, and basic metabolic processes of corneal cells. These studies were conducted in the Physiology Department at the Eye Institute and at the Mt. Desert Island lab in Maine. Dr. Edelhauser received a research training grant from the National Eye Institute in 1975. Among his pre- and postdoctoral trainees are Bernard G. McCarey, Eileen Masterson, Dayle H. Geroske, Frank P. Killey, Michael E. Stern, William J. O'Brien, and John L. Ubels.

Gerald B. Spurr (Ph.D., University of Iowa, 1954) became a member of the Physiology Department and of the Clinical Physiology Section at the VA Medical Center in 1967. His research interests are mainly in environmental physiology, regulation of body temperature, and clinical and subclinical malnutrition and their relation to work capacity. The latter research is being carried out in Colombia in collaboration with physiologists at the Universidad del Valle in Cali. Dr. Spurr, in conjunction with Dr. Hamilton, developed a clinical physiology teaching program for our medical students. Special correlation lectures in clinical subjects given by selected clinicians were coordinated with the basic lectures and in some cases given in the hospitals and accompanied by patient demonstrations. Dr. Spurr, a fine scientist and an effective teacher, has directed the medical physiology course from 1976 to the present.

Christopher A. Dawson (Ph.D., University of California) served as a postdoctoral fellow with Dr. Hamilton for three years before being appointed to the Physiology faculty in 1972. His research in pulmonary circulation initially involved perfusion of isolated lung and the study of interactions of passive mechanical and active vasomotor influences. He developed mathematical models to explain these relationships and also investigated the distribution of pulmonary vascular resistance and the effects of hypoxia, prostaglandins, and other agents on this resistance. Dr. Dawson, an acknowledged authority on pulmonary hemodynamics, has trained a number of graduate students and postdoctoral fellows, including Tawfic S. Hakim, Edward J. Quebbman, Michael B. Maron, and David M. Rickaby.

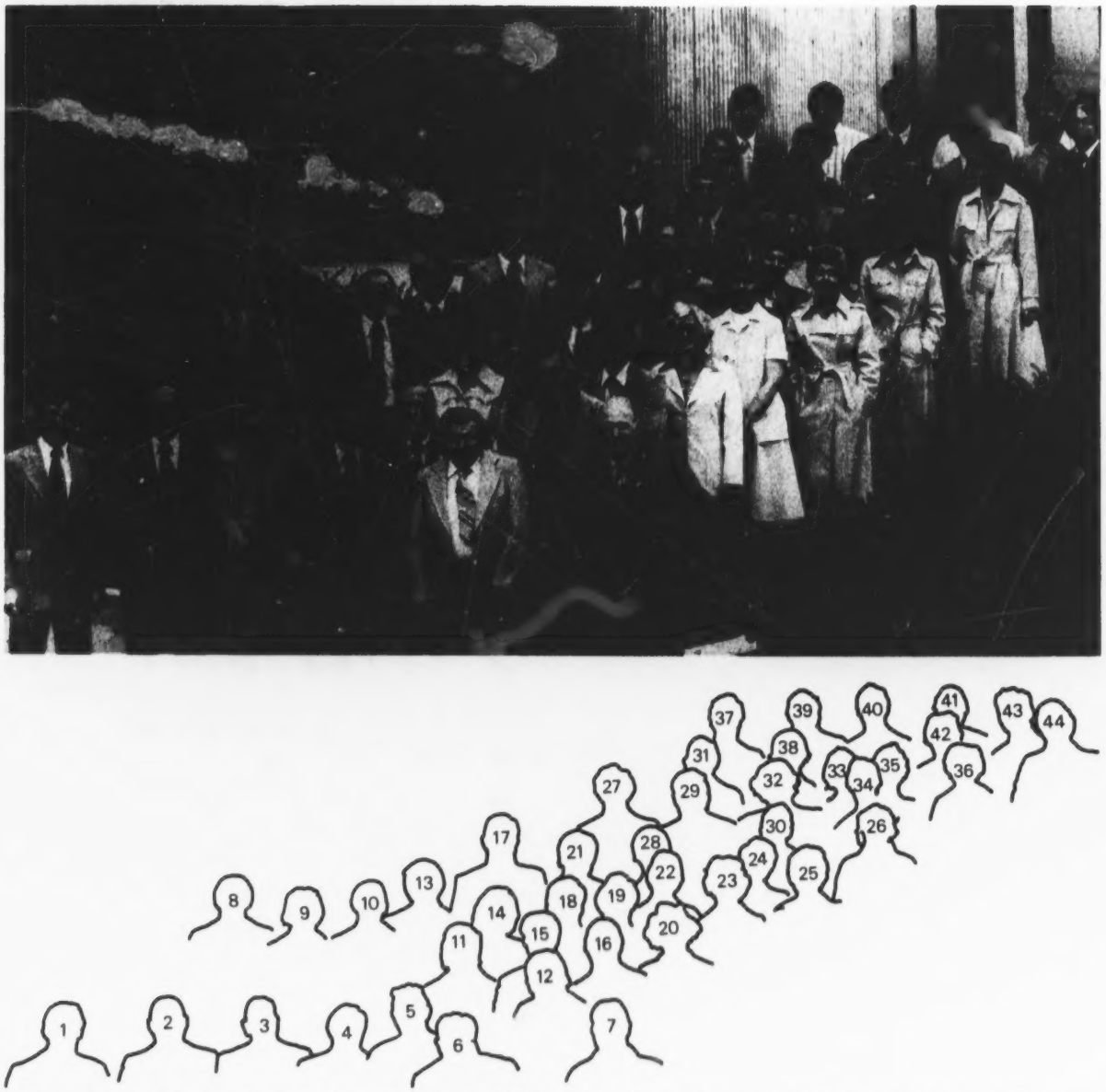
John P. Kampine (M.D., Ph.D., Marquette University), Professor and Chairman of Anesthesiology and Professor of Physiology, began his physiological research while a medical student and interrupted his medical studies after his sophomore year to spend one year as a U.S. Public Health Service predoctoral physiology fellow. After graduation and a year of internship, he spent three years as a USPHS postdoctoral research fellow with Dr. Smith investigating methods for studying hepatic circulation in the dog and the mechanism of irreversible shock. After receiving his Ph.D. in physiology, Dr. Kampine spent two years at NIH in Bethesda, Maryland in lipid chemistry working with Roscoe O. Brady on Gaucher's disease, Niemann-Pick disease, and leukemia.

He then returned to Marquette in 1967, became Assistant Professor of Physiology, and established his own research program, concerned primarily with neural control of the heart and circulation. During this period he simultaneously undertook a residency training in Anesthesiology under the direction of Ernest O. Henschel, then Professor and Chairman of that department. In 1974 he became Associate Professor and in 1979 became Professor and Chairman of Anesthesiology and Professor of Physiology. Since his return to this medical school in 1967, Dr. Kampine has been very active in cardiovascular research and in recent years has, with his colleagues and students, developed a large, active, and highly productive physiology research institute at the VA Medical Center. He and his staff are carrying out broad-range animal and human investigations into the factors controlling circulation and the effects of various anesthetics, including studies on the role of baroreflexes, sympathetic ganglionic transmission using intracellular recordings, tracking of extent and sites of central reflexes with [^{14}C] 2-deoxyglucose, role of blood vessel compliance in hemodynamic responses, intrapulmonary receptors, sympathetic sensitivity of arterial baroceptors, and the role of baroreflexes in exercise. Dr. Kampine has trained a number of graduate students and postdoctoral fellows, including R. L. Coon, D. R. Kostreva, P. V. Purtock, George Hess, Jeanne L. Seagard, Z. J. Bosnjak, Franz Igler, D. F. Stowe, and Thomas J. Ebert. Jon Nilsestuen, who also studied at this institute, received his Ph.D. under the direction of Dr. Coon.

Hubert V. Forster (Ph.D., University of Wisconsin) had worked with Jerome Dempsey at the University of Wisconsin, Madison on ventilatory responses to changes in P_{O_2} and P_{CO_2} and the relations of these elements to exercise and hypoxia. He joined the Department in 1972, and his subsequent investigations involved a series of well-designed studies aimed at determination of the possible mechanisms of the pulmonary response to exercise. Dr. Forster and his colleagues have investigated, mainly in awake ponies, the role of the carotid bodies, the effects of ambient temperature and limb movement, neural control mechanisms such as hilar nerve afferents, and brain hypoxia. Dr. Forster has trained a number of graduate students, including Paul E. Newton, John P. Kline, Roger Kaminski, Larry Pan, and Cheryl Flynn.

Julian H. Lombard did his graduate studies in this Department, working with Dr. Stekiel on the mechanisms of loss of vascular smooth muscle tone during hemorrhagic shock. He completed his Ph.D. in 1974 and spent three years with Brian Duling at the University of Virginia studying the role of hypoxia and myogenic factors in arteriolar response. He returned as Assistant Professor in Physiology at MCW. His research work in the subsequent years has involved the use of intravital microscopy and closed-circuit television in microcirculatory studies and the use of microvascular tonometry and P_{O_2} microelectrodes in the study of membrane potentials and vascular smooth muscle in hemorrhage and hypertension.

Other faculty members who held appointments in the Department of Physiology were Shirley A. Johnson, Diane Van Horn (who received her Ph.D. under Dr. Johnson), Felix E. Tristani, David F. Stowe, Kathryn J. Gaspard, Robert L. Coon, and Lois M. Sheldahl. Among important contributors to the Department during these years were three "super technicians," Harold E. Eick, Director of the Physiology Shop, Jill A. Barney, B.S., Chief Technician in Dr. Smith's stress testing lab, and Stephen Contney, M.S., microvascular technician



Faculty, staff, and graduate students, Physiology Department, MCW, 1978. 1. Henry Edelhauser; 2. William Stekiel; 3. David Glenister; 4. Howard Klitgaard; 5. Hermann Rahn (visiting lecturer); 6. Lyle Hamilton; 7. James J. Smith; 8. David Stowe; 9. Michael Maron; 10. Roger Kaminski; 11. Diane Van Horn; 12. John Kampine; 13. Phillip Clifford; 14. John Young; 15. Hubert Forster; 16. Christopher Dawson; 17. Allen Beranek; 18. Zeljko Bosnjak; 19. David Rickaby; 20. Jeanne Seagard; 21. Julian Lombard; 22. Carole Graff; 23. Lucille Maney; 24. Edith Sulzer; 25. Helen Russell; 26. Jill Barney; 27. Jon Nilsestuen; 28. Edward Zuperku; 29. Paul Newton; 30. Mimi Mick; 31. Mike Bohnsack; 32. David Kostreva; 33. Brenda Weyenberg; 34. John Klein; 35. Carole Porth; 36. Kathryn Gaspard; 37. Michael Burke; 38. Kevin Cummings; 39. Thomas Ebert; 40. David Merrill; 41. John von Colditz; 42. Michael Stern; 43. Harold Eick; and 44. Stephen Contney.

in Dr. Stekiel's laboratory. Out of the many technicians who served the Department well throughout this long period, these three were particularly outstanding.

Undergraduate Medical Student Teaching

The departmental teaching load was a heavy one during this period. It consisted of a two-quarter course in medical physiology, a two-quarter course in dental physiology, a course for medical technologists, and occasional lectures to nursing students as well as the graduate program. The prevailing philosophy at the school was that the primary job of faculty was teaching; research and other activities came second. The physiology staff adhered to this credo and long hours were spent not only in preparing lectures and in conferences with individual students but in numerous departmental meetings planning curriculum, devising and trying out new laboratory experiments, in group conferences with students, and oral exams.

In 1959 the smoked drums were ushered out and four Grass recorders introduced into the student lab. Within a relatively short period enough Grass recorders were purchased to supply all student groups. Dr. Stekiel and Harold Eick played key roles in the very consider-

able task of developing manuals, indoctrinating students, and introducing safeguards to minimize the jamming of the instruments and the dropping of transducers. A number of teaching experiments were conducted in the medical course during those years, including the design, execution, and reporting of some lab experiments by students themselves, informal "journal club" meetings, and tutorial or small-group discussion sessions.

The problems of training medical physiology were compounded by the steady increase in size of the student body. From a class size of 90 medical students in 1953, the enrollment gradually increased to 225 in 1979. Increases in the basic science budget and, in the case of physiology, a substantial graduate training grant were helpful in enabling an increase in faculty so that by 1968 (during an accreditation visit by the American Medical Association and Association of American Medical Colleges) the Department had 10 full-time and 5 part-time faculty, 4 postdoctoral fellows, and 17 other full-time and part-time staff. In 1964, with the arrival of Dr. Glenister, increased emphasis was placed on experiments with human subjects and several of these, mainly adapted from Dr. Landis' course at Harvard, were incorporated into the medical course. In 1968 with the arrival of Dr. Spurr, a clinical physiology correlation program was instituted and increasing emphasis placed on the presentation of pathophysiology along with the normal physiology. During the 1970s, while there was a notable decline in laboratory teaching in most basic sciences, particularly biochemistry and pharmacology, our physiology laboratory was not reduced and remained a vital element of effective medical student teaching.

In 1972 a report to the Dean on the medical physiology teaching program contained the following statements.

> The Medical Physiology course is currently being given in the second semester of the Freshman year; it consists of approximately 246 contact hours with about 90 hours of laboratory, 24 hours of Clinical Physiology and the remaining time in formal lectures, informal tutorial sessions, conferences, etc.
>
> It has been our departmental teaching philosophy to emphasize the integrated responses of the various regulatory systems of the body and the concept of homeostasis and physiological reserve. The course in Medical Physiology consists of a coordinated effort featuring [1] lectures, [2] close coordination of lecture material with the textbook assignments, [3] a series of small group laboratory exercises on animal and human subjects, [4] tutorial and discussion sessions in small groups (10 to 12 students), [5] carefully planned Clinical Physiology sessions to emphasize the pathophysiology and [6] additional sessions for review of specialized areas before exams, teaching films, and special audiovisual sessions. In recent years there has also been an increase in correlation teaching between Physiology and other departments, especially with Anatomy, Medicine and Pediatrics.
>
> The primary objective of the medical teaching program has been to make available to the student a core of basic physiology fundamental to his needs for clinical medicine. But since we all learn in different ways, we try to provide a maximum range of learning techniques so that the individual student may select the mixture which is most effective for himself.

Graduate Program

When Dr. Smith arrived in 1952 there was no graduate program in Physiology. Two master's degrees had been previously awarded—one in 1941 to John S. Hirshboeck (later to become Dean of the Medical School) for study of the "Erythrocyte Factor in Blood Sedimentation" and the other to Edgar End in 1943 for studies in "Helium-Oxygen Mixtures in the Prevention of Divers Bends." However, approval for graduate studies in the basic medical sciences at Marquette University had been withdrawn during the war years because of inadequate staff and facilities. In 1952 the university reinstated the Ph.D. program in Physiology.

At this time two postsophomore fellowship positions were established for carefully selected medical students. The fellowships consisted of a five-quarter, full-time master's program to be started immediately after their sophomore year of medicine. The students would then resume their regular medical curriculum in the fall of the succeeding year. Approximately eight students successfully completed this M.S., M.D. sequence over the next several years. Three returned for an additional three-year graduate program after their graduation and internship and received their Ph.D. in physiology: Edward F. Banaszak, John P. Kampine, and Joseph R. Logic. Others who remained in academic pursuits were Peter A. Kot and Roger P. Johnson. After this beginning, the great majority of graduate students were "straight Ph.D." students. However, a tradition of encouraging outstanding professional students to pursue Ph.D. work in the Department was maintained, and in the succeeding years a number of "double degree" students were trained, including Edward J. Quebbman (Ph.D., M.D.), Anthony J. Steffek (Ph.D., D.D.S), Thomas J. Ebert (Ph.D., M.D.), and Carol J. Porth [Ph.D., M.S. (nursing)].

The first Ph.D. in the history of the Department of Physiology was awarded to Read R. Nielson in 1961. Nielson received his M.S. at the University of Iowa, served in the U.S. Navy, and then came to Marquette and did his graduate work under Dr. Klitgaard. His thesis was entitled "Succinic Dehydrogenase Activity in the Intact Rat and in Excised Tissues after Thyroidectomy." Dr. Nielson is now Professor of Biology at Miami University, Oxford, Ohio. Dr. Smith trained a number of graduate students and postdoctoral fellows, including Edward F. Banaszak, John P. Kampine, Joseph R. Logic (with Dr. Stekiel as co-director), James P. Filkins, Sandy I. Helman, Thomas A. Wiedmeier, Michael L. Bonin, Dennis L. Murphy, Patrick E. Lentz, Daniel J. McDermott, Daniel J. Loegering, Carol J. Porth and Thomas J. Ebert.

The department graduate program was aided considerably by a long-term NIH Graduate Training Grant awarded in 1957–64, renewed in 1964–69, and again renewed in 1969–74 with a supplement in 1966. These were at that time the largest science grants in the history of Marquette University. The graduate program was also helped by the steady increase in departmental extramural research grants.

Foreign Exchange Programs, Visiting Scholars, and Lecturers

Because of a common interest of the two laboratories

in the physiology of shock and with help of a Rockefeller Foundation grant, a two-year scholar exchange program was arranged during 1962–64 with Professor A. G. B. Kovach of the Physiology Institute of the University of Budapest. Under this program two young faculty from Budapest spent a year in our Physiology Department and two of our faculty worked at the Budapest lab. In 1969, Keith Cooper, a fellow and tutor at St. Peters College, Oxford and head of the Medical Research Council Unit in the Department of Medicine at Oxford University, spent six months as a Visiting National Science Foundation Research Professor at the Medical School working with Dr. Smith in cardiovascular physiology. After his stay at Marquette, Dr. Cooper became Professor and Chairman of Physiology at the University of Calgary and later Dean of the Graduate School at that University. In 1972 A. Hamamdzic of the Physiology faculty of the University of Sarajevo in Yugoslavia spent a year as Fulbright Fellow with Dr. Smith on a project concerning the role of lysosomal hydrolases in irreversible traumatic shock. During this same year Wolfgang Waller of the University of Wurzburg Eye Hospital spent six months in Dr. Edelhauser's lab studying corneal cryopreservation.

In 1959–60 Dr. Smith was a Visiting Fulbright Professor at the University of Heidelberg in Germany and also worked with Professor J. Schmier at the Max Planck Institute on "Mechanisms of Irreversible Shock." In 1965–66 Dr. Rieck spent a sabbatical year at the University of Edinburgh working on "Radiation Effects on Cancer Cells." From 1969 to 1976 the Physiology Department had various joint programs with the Physiology Department of the University of West Indies in Jamaica. Drs. Smith, Klitgaard, Hamilton, and Glenister served as visiting lecturers and examiners. In 1973 G. Norris Melville spent a six-month postdoctoral period with Dr. Hamilton; Dr. Melville later became Head of the Physiology Department at the University of West Indies. As a result of these ties, other University of West Indies medical students (all honors award graduates) came to the Department for graduate study. These included Terrence Forester, Stanhope Maxwell, and Colin Nath. Feona Hansen (who received her Ph.D. under Dr. Diane Van Horn) served a postdoctoral fellowship at the MRC Research Institute in Jamaica. In 1972 Dr. Spurr began a long-range joint study (which has continued to the present) with Professor Barac-Nieto in the Physiology Department, University del Valle in Cali, Colombia, on the relationship of physical work capacity to nutritional status in adults and more recently in children.

In 1974, through the efforts of Marvin Wagner of the Department of Surgery and Dr. Stekiel, the trustees of the Julius M. Babush estate awarded a grant to the Department of Physiology, the proceeds of which are used to provide annual "Physiology Merit Awards" to selected graduate students of the Department for outstanding scholarship and research. The students who have received the Babush Merit Award are Eileen Masterson, David R. Harder, Jeanne L. Seagard, John P. Klein, Lawrence Pan, John Osborne, David C. Merrill, Hans van Brederode, and David Zawieja. Their names are inscribed on a commemorative plaque in the Department office.

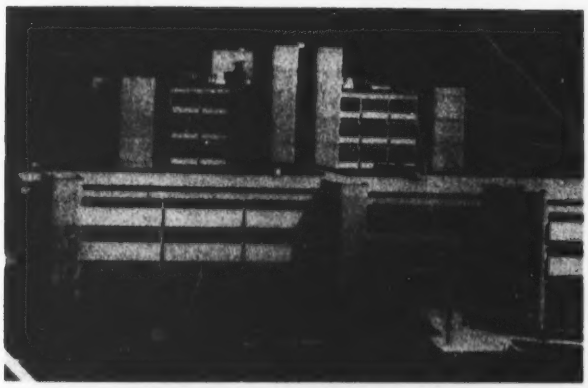
In 1974, the annual Alvin F. Rieck memorial lectureship was established and a number of distinguished scientists have been invited to give this presentation. The Rieck lecturers have been Roy P. Forster (Dartmouth), David B. Dill (University of Nevada), Daniel C. Tosteson (Harvard), John T. Shepherd (Mayo), Hermann Rahn (Buffalo), Thomas Maren (Florida), Leon F. Fahri (Buffalo), and Franklyn Knox (Mayo). During these years a number of other outstanding investigators have given lectures and seminars in the Physiology Department. Among these were Homer Smith (NYU), Carl J. Wiggers (Western Reserve), Alan C. Burton (Western, Ontario), A. G. B. Kovach (Budapest), Arthur C. Guyton (Mississippi), Walter C. Randall (Loyola), Harold Green (Bowman-Gray), Stanley Sarnoff (NIH), Eric Neil (Middlesex, London), Robert Pitts (Cornell), Mark Nickerson (Manitoba), Theodore Cooper (NIH), Sidney Udenfiend (NIH), John R. Pappenheimer (Harvard), Sir George Pickering (Oxford), and Francis M. Abboud (Iowa).

General

Life in the Department also had its lighter side. In the 1960s, when the staff was limited in size, late Friday afternoon staff meetings were frequently adjourned to the barroom of the nearby Stratford Hotel where the faculty commiserated with each other on topics such as "the latest (idiotic) plan of the curriculum committee" or "how to get a grant without doing the pilot study." In March 1974 at the height of the student uprisings, the freshmen medical students, listening to one of Dr. Klitgaard's endocrine lectures, were shaken out of their usual torpor by a streaker, who raced the length of the auditorium. The Physiology Department felt honored that we were chosen as one of only two such visitations at the university. In the Marquette University student newspaper, the chief of security cited this episode as "lewd and lascivious behavior" and hinted darkly that severe action would be taken against any further perpetrators. In any event, there were no repetitions—much to the disappointment of the students.

In the 1970s a number of changes occurred at Marquette University and in the Department. The Medical School and Marquette University severed their legal and academic ties primarily because the state legislature had for the first time voted a subsidy from the State of Wisconsin to the Medical School; the administration felt that the establishment of a separate corporation would, in view of the religious affiliation of Marquette University, avoid a possible church-state conflict of interest. Thus, the Medical School became a separate, private, free-standing corporation, known as the Medical College of Wisconsin. However, despite state subsidy, the Medical College now faced serious financial and other problems during this period of worsening economy. Efforts toward a more effective affiliation with Milwaukee County Hospital, the main clinical teaching institution, ran into difficulty over the increasing burden of teaching costs at the hospital. The increasing faculty size, particularly in clinical departments, represented a growing financial burden. In addition, there was a pressing need for a new physical plant to house the expanded faculty and student body but no immediate evident source of funds.

In 1975, the Board of Directors appointed David Carley, a well-known Wisconsin business and civic



Third (and current) home of Medical College of Wisconsin (1978–) in Milwaukee Regional Medical Center in Wauwatosa, a western suburb.

leader, as President of the Medical College of Wisconsin. The decision was made to build a new medical school on the west side site of the Milwaukee County Hospital grounds in the suburb of Wauwatosa, about eight miles west of the Marquette University Campus (then the site of the school). Dr. Carley (Ph.D., economics, University of Wisconsin) proved to be an inspired choice. A man of unusual drive, organizational ability, and political acumen, he secured pledges of federal, state, and county funds and a private bank loan totaling $27 million within two years, enough to begin construction of the newly planned $44 million physical plant. Ground was broken for the 333,000-square-foot building in 1976 and the building was occupied in 1978. This was the largest single fund-raising venture in the history of Wisconsin. Completed in record time, this was a magnificent achievement and proved to be a tremendous physical and psychological boost to the school. This development, attributable primarily to David Carley, set the solid foundation for the continued financial and academic growth that the Medical School under the subsequent able leadership of Dean Edward J. Lennon has since enjoyed.

In the latter 1970s Dr. Rasch left the faculty to become Professor and Physiology Chairman of the newly established East Tennessee Medical School at Johnson City, Tennessee. In 1979 Dr. Klitgaard left to become Professor and Director of Basic Sciences at the Marquette University School of Dentistry; a day-long gala was held to honor the man who had been so intimately associated with the development of this Department for the last 26 years. In 1979 Dr. Smith became Deputy Director of the Cardiac Rehabilitation Center and Director of the Human Performance Laboratory at the Milwaukee VA Medical Center, and with Dr. John P. Kampine, completed a textbook on *Circulatory Physiology—The Essentials.* During the same year, in keeping with the mandatory retirement policy for heads of departments, Dr. Smith resigned as Chairman. After a nationwide search, Allen W. Cowley, Jr. was appointed the new Chairman in 1980.

Current Era—the Cowley Years

Allen W. Cowley, Jr. was born in Harrisburg, Pennsylvania in 1940 and received his B.A. degree from Trinity College, Hartford, Connecticut and his M.S. (1965) and Ph.D. degree (1968) from Hahnemann Medical College in Philadelphia, Pennsylvania. He served a postdoctoral fellowship with Arthur C. Guyton, Professor and Chairman of the Department of Physiology, University of Mississippi Medical Center, from 1969 to 1971 and was instructor (1968–69), Assistant Professor (1969–72), and Associate Professor (1973–75) of Physiology and Biophysics at the University of Mississippi Medical Center. He was a Visiting Professor of Physiology at Harvard Medical School in 1974–75 and then Professor of Physiology and Biophysics at the University of Mississippi Medical Center from 1975 to 1980, when he was appointed Professor and Chairman of the Department of Physiology of the Medical College of Wisconsin—the third man to hold that position in the 59-year history of the Department.

At the time of the appointment at the Medical College of Wisconsin, Dr. Cowley already had an outstanding research and academic record with over 40 major scientific publications, 15 reviews and book chapters, an American Heart Association established investigatorship, several NIH research grants, and membership on a number of NIH Study Sections and editorial boards of leading physiological journals. His major fields of research interest were overall control of the circulation, the role of baroreflexes in circulation, the renin-angiotensin–aldosterone system, vasopressin in the regulation of body fluids and electrolytes, and systems analysis of physiological control systems with emphasis on the role to kidney and of endocrines.

At the time of Dr. Cowley's appointment, there remained on the physiology faculty Drs. Stekiel, Hamilton, Edelhauser, Spurr, Dawson, Forster, Smith, Kampine, Lombard, Stowe, Gaspard, Coon, Sarna, and Tristani. During the next several years a number of very competent young physiologists were added, including Jean-Francois Liard, M.D., Ph.D. (Lausanne); Billy J. Barber, Ph.D. (Kentucky); Jeffrey L. Osborn, Ph.D. (Michigan State); Richard J. Roman, Ph.D. (University of Tennessee); John L. Ubels, Ph.D. (Michigan State); and Carol J. Porth, Ph.D. (Medical College of Wisconsin). Additional faculty with secondary appointments in the Department of Physiology included David R. Harder, (MCW); David R. Kostreva, Ph.D. (MCW); Zeljko J. Bosnjak, Ph.D. (MCW); Jeanne L. Seagard, Ph.D. (MCW); and Susan C. Walgenbach, Ph.D. (University of California, Davis).

Dr. Liard received his early training at the Institute of Pharmacology of the University of Lausanne, in the Department of Physiology and Biophysics of the University of Mississippi Medical Center, and the Cleveland Clinic Foundation. From 1977 to 1983 he was Director of the Cardiovascular Research Institute of the University of Fribourg (Switzerland) before joining the faculty of MCW as Professor of Physiology. Dr. Liard is internationally recognized as a leader in research on cardiovascular regulation and renal function in hypertension. His past investigations include studies on distribution of blood flow in normal states and hypertension, the effects of autonomic blockers, the role of baroceptors and tissue catecholamines after renal denervation, renin-angiotensin mechanisms, circulatory concomitants of altered blood volume states, and the physiological and pathological roles of vasopressin.

Dr. Barber received his M.S. in physics and his Ph.D. in physiology from the University of Kentucky. He

Dr. Allen W. Cowley, Jr., third (and current) Chairman of Physiology, Medical College of Wisconsin (1980–).

served a postdoctoral fellowship at Bowman-Gray Medical School and was an Instructor and Assistant Professor in the Physiology Department of the University of Mississippi before coming to MCW. He has considerable experience and background in mathematical modeling, electronics, instrument design, interstitial fluid dynamics, and regulation of the microcirculation.

Dr. Osborn received his B.A. from Amherst and Ph.D. from Michigan State, where he worked on renal function, sodium excretion, and plasma renin activity in the newborn. He then served a postdoctoral fellowship in the Department of Internal Medicine at the University of Iowa and joined the Physiology staff in 1981. His primary research interests involve the neurohumoral control of renal function, particularly tubular sodium reabsorption, effect of brain angiotensin on the kidney, and the reflex regulation of renal sympathetic nerve activity in the conscious dog.

Dr. Roman received his B.S. in chemical engineering from Rutgers University and his Ph.D. in pharmacology from the University of Tennessee. He then served four years as Research Fellow and Research Associate in Physiology under C. P. Lechere at Harvard Medical School and one year in electron probe microanalysis there before joining MCW in 1981. His research interests include water and sodium diuresis, prostagladin and renal function, electron probe microanalysis, pressure diuresis, and renal tubular transport in hypertension.

After receiving his Ph.D. at Michigan State University, Dr. Ubels served a postdoctoral fellowship at Michigan State and at MCW with Dr. Edelhauser before joining the Physiology faculty at MCW. His previous research experience has been in the comparative physiology of vertebrate retinas and oxygen toxicity and electrophysiology of retina. His current research interests are corneal physiology and toxicology, effects of vitamin A on corneal function, and the preparation of models for the study of corneal toxicity.

In the period since the arrival of Dr. Cowley, very impressive strides have been made in the academic and research programs of the Department. There is a high-quality undergraduate medical teaching program characterized by a well-integrated lecture program and a strong, effective, well-received laboratory teaching program. Research productivity has greatly increased in terms of number of outside grants received, number of publications, and number of presentations at national and international meetings. Extensive collaborative research programs have been developed with other departments at the Medical School, including Anesthesiology, Ophthalmology, Medicine, Pediatrics, Surgery, Neurology, Cardiology, Pharmacology, and Biomedical Engineering at Marquette University.

The graduate program is strong with the provision of high-standard, basic physiological research in areas of respiratory function, pulmonary circulation, blood pressure control, renal function, visual mechanics, cellular transport, nutrition, work physiology, vascular smooth muscle, applied physiological research, and mathematical physiology. In addition, the Department has installed a large-capacity computer system capable of handling all on-line and off-line research requirements of each faculty member of the Department as well as all departmental administrative bookkeeping and word processing requirements. The system is composed of a 512-kilobyte core unit with 5 megabytes of memory and 24 terminal input ports. A systems programmer helps Dr. Barber in conducting the day-to-day operation of the computer system.

Undoubtedly the centerpiece of the academic program, however, is the extensive $3.2 million Program Project Research Grant awarded to the Department in 1982—the largest basic science grant ever in MCW history. Dr. Cowley is program director and Dr. Liard co-director of the five-year grant, which is in the area of "Blood Pressure—Determinants and Controllers." It is a joint effort involving seven faculty members from Physiology and one from Medicine: Drs. Cowley, Liard, Stekiel, Lombard, Barber, Roman, Osborn, and Velasquez. The general objectives of the program are to broadly evaluate the mechanisms of arterial pressure regulation in normal and hypertensive states utilizing a variety of experimental and analytical techniques. Emphasis is placed on the control of body fluid volume by the kidney and on mechanisms that determine systemic vascular smooth muscle tone. Special emphasis is placed on the utilization of computer systems techniques to evaluate the complex interactions of cardiovascular function. Special objectives are the study of *1*) vasopressin secretion and cardiovascular function in essential hypertension, *2*) direct influence of arterial pressure on renal tubular function, *3*) neural and endocrine control of water and electrolyte balance and renal function, *4*) control of vascular smooth muscle in spontaneous and volume-expansion hypertension, and *5*) integration of the cardiovascular system.

Our appreciation goes to several people who gave generous help with background materials for the history, particularly Richard Katschke, director of public relations; William Maher; Beth Lange, librarian, Academy of Medicine; and Walter Zeit, Howard Klitgaard, William Stekiel, and Allen W. Cowley, Jr., who checked the text for accuracy.

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